ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXX. No. 21.

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INDUSTRIAL NOTES.......... 424

Coal dust for fuel is reported as being experimented with on some of the steamers of the North German Lloyds and Hamburg-American lines. The coal dust is blown into the furnace by a jet. The fuel is very cheap, but whether it will give out as much heat as the ordinary steam coal and will give satisfactory results in other ways remains to be seen.

The Board of Trade Building, in Chicago, reports Gen. William Sooy Smith, who has been examining the building for the board, is settling unevenly and demands immediate and costly repair to keep it from collapsing. General Smith says that the structure rests on a clay, or rather mud substratum, full of water, and this great weight is gradually squeezing this water out and causing an uneven settlement under points of greatest weight. This clay mud extends down 45 ft. below the basement to a stratum of hard-pan, and the rock is 83 ft. below the surface. He proposes to sink masonry piers to hard foundation at a cost of about $150,000. The building cost $1,730,000 in 1885; it has a base of 173 x 225 ft. and is 140 to 160 ft. high, with a 32-ft. square tower 310 ft. high. The president of the Board of Trade said repairs would commence at once.

The power station chimney of the Brooklyn City Railway Co., at Kent and Division Aves., Brooklyn, will be 312 ft. high when finished. The concrete base is 66 ft. square and 7 ft. deep and rests upon 1,081 piles. This concrete is capped by stepped courses of granite masonry 14 ft. high and 65 ft. square at the base. The outer shell of the chimney has a diameter of 32 ft. and tapers to 16 ft. at the top and is 32 ins. thick. The central flue has a uniform thickness of 28 ins. The iron cap weighs 14,000 lbs. The estimated weight of the whole chimney is 5,800 tons.

The New York Rapid Transit Commission, after a six weeks' rest, held a meeting on Nov. 20. As usual little was done, the only business being to report the completion of the survey of certain routes by the commission's engineers, which routes were approved of by the Commission for elevated lines. Messrs. J. W. Reno and J. G. Hillam presented a scheme for an underground road on the Broadway line originally laid down. They offered to pay $150,000 toward the expenses of the Commission and give the city $1,000,000 of the stock of the proposed company; and in answer to a question Mr. Reno said he would give in confidence at the next meeting the names of the capitalists interested. The Reno system has been fully described in this journal.

The Baltimore ship canal project, to connect Baltimore directly with the Atlantic by a canal across the Maryland peninsula, is being actively agitated again by the Maryland press. The various routes have been already surveyed and reported upon at various times by Col. Wiliam P. Craighill, Corps of Engineers, U. S. A. The Sassafras River route would require a 16-mile canal and cost $8,000,000; but it is too far north and would be closed in cold weather. The Choptank River route, opening at Lewes, Del., would be 37½ miles long and cost under $18,000,000. The third and favorite route is laid in an almost straight line from a point opposite Baltimore to Lewes, and would require a 50-mile canal, costing about $34,000,000. This canal would save 200 miles in the trip to and from the sea, or a whole day to the average ship.

A bridge between Cincinnati, O., and Covington, Ky., over the Ohio River, is proposed, according to press reports, by a party of New York, Pittsburg and Cleveland capitalists, who also propose to get control of the street car lines connecting the cities named above. It will be a combined railway and highway bridge, and will cross the river with one cantilever span, according to the reports. No definite plans have been decided upon, however. The engineer, it is stated, is G. W. G. Ferris, of Ferris wheel fame, and his partner, M. Kaufman, of Pittsburg, Pa. Among the others interested are J. Shepherd, President of the Cleveland St. Ry. Co., and Chas. A. Otis, President of the Otis Steel Works, of Cleveland, O. It is stated that permission, from the government presumably, has been secured for the construction of the bridge.

The triple screw protected cruiser "Columbia" completed her official run in the open sea off Boston, Mass., Nov. 18, and averaged 22.81 knots per hour over the 82.8-knot government, measured course. This was done with a forced draft, and at the finish the port engine showed 136½, the starboard engine 134, and the center engine 132 revolutions per minute. The steam pressure was 158 lbs. and the developed horse-power was 21,500. She is credited with a speed rate of 24.77 knots in passing the first of the stake boats on her southerly trip; but foaming boilers caused her to drop to 21.11 knots between the next two boats. This foaming is claimed to have caused loss of speed throughout the latter part of the trial, and she crossed the finishing line at a 22.76 knot rate. At the finish of the north and first run she was spurting at the rate of 25.31 knots, and her builders claim that except for the reduction of speed due to the cause given the "Columbia" would have averaged at least 23 knots for the whole course of nearly 83 knots. As the contract speed was 21 knots, this trial trip earns a bonus of $350,000 for her builders, Cramp & Sons, of Philadelphia.

No very serious railway accident has been reported this week, the worst having been a rear collision of freight trains, Nov. 19, on the Pennsylvania R. R. at Newark, N. J., in which one man was killed. A failure of one of the new automatic signals is given as the cause of the accident.

A dynamite explosion, due to carelessness in thawing the frozen material, occurred Nov. 14 on the Chicago drainage canal works. Two laborers took a quantity of frozen dynamite to a fire to thaw it, when it exploded, blowing the men to pieces. The shock was felt at Joliet, nine miles distant. Unfreezable dynamite and different methods of thawing ordinary dynamite were described in our issue of March 2, 1893.

Canal boat propulsion by electricity was successfully tested on the Erie Canal on Nov. 18, near Rochester, in the presence of Governor Flower and a number of invited guests. This trial was in response to an appropriation of $10,000 for this purpose by the New York Legislature. The Westinghouse Electric Co. accepted the invitation, and it was their apparatus that was tested. The boat used was a 98-ft. canal boat, drawing 3 ft. of water when loaded with 150 tons of sand. According to press accounts, two 25-HP. standard street railway motors were connected to the shaft of a screw propeller, in the stern of the boat, by the same form of gearing used on street railways. Two 12-ft. trolley poles conveyed the current from the overhead wires supplied by the Rochester Street Ry. Co. The speed obtained over the ¾-mile course was nearly 6 miles per hour, which is faster than the law allows by about one-half. The cost of the electric propulsion is not stated, though electricians claim that boats can be so handled for 60 cts. per day, as compared with $2 to $3 per day for horses.

An "important if true" bridge and tunnel scheme reported as under consideration at Pittsburg, with the object of furnishing rapid transit from the down-town business district of the city to the suburban residence section on top of the bluffs south of the Monongahela. At present travel between these points is hampered by the necessity of changing cars when the foot of the bluff is reached, the ascent of the bluff being made by cable inclines. It is now proposed, according to press reports, to construct a high bridge and viaduct designed solely for electric railway traffic, and therefore admitting of light construction. This structure would start from Ferry St. and Fifth Ave. and extend to the Monongahela, which would be crossed with a channel span of 700 ft. Both the bridge and the viaduct on the west of it will have a 5% grade, which will be maintained when the face of the bluff is reached and the tunnel begins. The total length of the tunnel is given as 1,700 ft. The Pittsburg & Mansfield Street Ry. Co. is the corporation to which this enterprise is ascribed. Mr. Elliott Holbrook, late Superintendent of the Pittsburg Division of the Baltimore & Ohio R. R., is President, and Mr. E. K. Morse is Chief Engineer.

On the Brooklyn Bridge 20-ton locomotives are to replace the 10-ton engines for switching purposes, and the first one was operated on Nov. 19. The new engine can drag eight loaded cars.

The new lock of the Sault Ste. Marie Canal was completed on Nov. 1, as far as the masonry was concerned. The gates for the lock are under contract, and General Poe is quoted as saying that he expects the whole canal to be completed by the spring of 1896. The lock masonry on the Canadian Canal has also been completed, and the completion of all work on that canal is promised by July, 1894.

The Massachusetts Highway Commission is holding public meetings for the discussion of road improvement throughout the state, and proposes to hold one meeting in each county during the winter.

A Maryland state road law has been framed by the Maryland Road League, and is to be submitted to the State Legislature at its coming session. The law suggests the creation of a state engineering advisory board, to be placed at the service of the counties and in charge of a competent civil engineer at a salary of $5,000 per annum. The counties are to retain entire control of all road administration, with the finances and general control in the hands of the county commissioners. But the report also advises the formation of a county board of three members, serving for three years, to which the administration of roads and bridges should be committed, this board to have the benefit of expert advice and assistance. Constant supervision and repair of roads by special working forces are strongly recommended. Stone-breaking machines are to be purchased by the State Engineer and set up at convenient places, and the stone supplied to county boards at cost. The State Engineer is to report annually to the Governor on the condition of roads and bridges in the state, together with estimates of costs, expenses, etc. The bill abolishes the payment of road tax by labor, and substitutes direct taxation.

The longest iron railway bridge in Germany, says a Berlin news item, has just been completed across the Vistula, between Forden, in Prussian Poland, and Cumse. It is 4,350 ft. long and cost 8,000,000 marks, or about $2,000,000.

The "City of Lowell" is a twin-screw steel steamer launched this week, at Bath, Me., for the Norwich & New York Transportation Line. This steamer is 230 ft. long, 66 ft. extreme width and draws 13 ft. loaded. She is to be propelled at a 20-mile rate by two triple expansion engines of 4,500 HP. The designer is Mr. A. Carey Smith, of New York.

The fluctuations of latitude at Waikiki, Hawaiian Islands, have been very accurately determined by the U. S. Coast Survey, and are given in Bulletin No. 27 as 0.62 second, with apparent period of 378 days, the maximum latitude occurring on April 9 and the minimum on Oct. 2. As a second of latitude is about 60 ft. this indicates a "wobbling of the pole" in a circle having a radius of about 18½ ft. The fact of this "wobbling" has been well determined for many years, but if we remember correctly it has generally seemed to be in a somewhat shorter radius.

Cement and clay products from Sweden were exhibited at the World's Columbian Exposition, Chicago, by the "Sound Exhibition, Sweden," under which name eight firms united to show in and about the Swedish Building common, fire, yellow and red facing brick, tiles, drain and sewer pipes, pottery ware, chalk, Portland cement and the products of coal mines, all of which they are prepared to ship from the ports of the sound. The material for the entire façade of the Swedish Building was made by these firms, including stairways, balconies and floors and brick and terra cotta walls.

The Corinth Canal, it is officially announced from Athens, under date of Nov. 7, was to be opened to general traffic on Nov. 9.

IMPROVEMENTS IN STADIA MEASUREMENTS.

At the meeting of the Boston Society of Civil Engineers on Oct. 18, Prof. Robert H. Richards presented a paper on a new system of measurements by the stadia. The following abstract is from a bulletin issued by the Society:

The difference between Professor Richards' apparatus and that commonly used in stadia work is that he uses no stadia cross-hairs, but the angle, instead of being that subtended between two cross-hairs, is the angle of deflection caused by introducing a very flat prism over one-half the object glass of the telescope, whereby the rays from two separate points, having an angular distance of about 1 in 100, are made to appear side by side. A great advantage claimed for this method over that of the two stadia hairs is that this angle is fixed unchangeably when the prism is ground, and that the angle of the prism, once determined, no change can subsequently occur. But greater than this is the advantage of the telescope provided with the prism, which can be used without the necessity for a fixed and steady support, just as a sextant can be used from a boat in making a hydrographic survey.

In some ways the principle is analogous to that found in the operation of the sextant, for, whereas in the sextant two images of distant points are brought so as to coincide, in Professor Richards' telescope a fixed target at one end of the stadia rod is seen coinciding with some division on the graduated scale of the rod dependent on its distance from the observer. The error incident to the setting of one cross-hair on a given division and of deciding just where the other cross-hair covers the scale is thus removed, and the whole action of the eye is reduced to merely deciding where one image (which may be in the form of a vernier) is superimposed upon another image, which is that of the scale itself.

During the lecture a small telescope magnifying ten times was circulated among the members, who, while holding it in hand, without other support, readily measured the distance of their eyes from a stadia board on the platform. It is obvious that such measurements could not be made by ordinary stadia hairs and with a telescope thus loosely held in the hand. Professor Richards detailed various experimental tests made with telescopes of various powers and under various circumstances. These tests, though not fully completed, indicated that a great degree of accuracy could be obtained, such that the probable error of a hasty series of readings would not exceed over 1 in 1,000 to 1 in 3,000, according to the power of the telescope used. Some of the lines measured at a single sight were about one mile in length, and in these the same high degree of accuracy of 1 in 3,000 was obtained, though the experiments were not sufficiently numerous to demonstrate with certainty the possibilities of the method. For these long distances two light cardboard targets were used, placed one at the zero point and the other sliding loosely along a 100-ft. steel tape. The tape was made square to the line of vision very simply by the use of the well-known optical square, consisting of a small prism held in the hand. In the past much difficulty has been found in getting prisms ground with sufficient accuracy, but some of those made by Alvan Clark were stated to have performed the duty required and to be so nearly true planes that their radius of curvature was about seven miles.

At the close of Professor Richards' remarks, Mr. Fitz Gerald, President of the society, briefly alluded to some of his own experiences in stadia measurement, and to the effect that its remarkable advantages for topographical work were not nearly so well appreciated as they should be by engineers. He stated that by this method of Professor Richards it apparently was possible to almost instantly measure a distance of over ¼ to ⅓ mile with even greater accuracy than could be obtained in ordinary chaining, and that even with the old methods of telescopic measurement it was very easy to secure as high a degree of accuracy as could be represented by a drawing to any ordinary scale.

TURBINES.

At the meeting of the Boston Society of Civil Engineers on Nov. 15 a paper entitled "Notes on Water Power Equipment," by Mr. A. W. Hunking, was read by the secretary. The following notes on this paper are taken from a bulletin issued by the Society:

Mr. Hunking stated that the census of 1880 gave the number of water-wheels then in use in the United States as 55,000, and that the total power developed was only about 5% of the total available power in the country. He estimated that to-day there are upward of 70,000 water-wheels in use in the United States, but after recounting the great and noted water powers like Lowell, Holyoke, Minneapolis, Spokane and others, said that a liberal estimate of all these would take only about 2,000 turbines, showing that the overwhelming majority of all the turbines, or over 68,000, are at the inconspicuous country mills, and that the conditions affecting these do not receive their fair share of consideration when discussing such questions as value of water power, etc., in the general way.

The method of testing as at the Holyoke flume and the sharp competition have resulted in producing, as standard American turbines of to-day, several makes which yield an efficiency equal to that of the old-time Boyden turbine, at an average of about one-fourth its cost, horse power being the same. Turbines may now readily be procurred, yielding 80% of the theoretical power in the water. Such a wheel, if used under conditions such as existing at Lowell, Lawrence or several of the large leased powers, could be paid for at market rates rather than take a wheel yielding 70% of useful effect as a free gift, as may be readily demonstrated. Thus, for a mill using 600 HP., the extra water used to give the same power by the wheel of smaller efficincy, would, at a rental of $20 per horse power per year, cost about $1,500 per year, and the 600 HP. 80% turbines could be put in for about $15,000. In country mills, where for six or seven months of the year surplus water runs to waste, the saving would be proportionally less, but the author maintained that the cases were extremely rare where true economy would not justify the more expensive and more efficient wheel.

The use of fewer buckets in the modern turbine was ascribed by the author to Mr. John McCormick, and for this he said Mr. McCormick was entitled to the everlasting gratitude of every millwright, by reason of the lessened liability of the wheel to clog with leaves, driftwood and eels. Other makers have followed in the same improvement, and the increase in average practical efficiency is marked and has been made without sacrifice of the best efficiency shown in the testing flume. The diameter of the smallest opening in these modern turbines is from two to three times as great as in the most favored Lowell turbines of 25 years ago of same power. The higher rotative speed of modern turbines is also commonly of great advantage, as is also the reduced diameter. Mr. Hunking cited the case of the Tremont and Suffolk mills at Lowell, where in the same space and same wheelpit formerly occupied by a single Boyden turbine, making 65 revolutions per minute and yielding 154 HP., two modern, small, high speed turbines were placed, yielding together about 300 HP., at 88 revolutions per minute, though, of course, with a correspondingly increased draft of water.

Mr. John R. Freeman alluded to the hundreds of pages of abtruse mathematics with which certain German professors had attacked the problem of turbine design, stating that old John McCormick's jack-knife and a block of pine had been instruments of greater practical utility in advancing the art than all these formulas.

At the request of the president, Prof. Dwight Porter gave a brief outline of the aims and methods followed in the instruction relative to turbines in the course on hydraulic engineering at the Massachusetts Institute of Technology. No attempt was made to treat the problem from the purely mathematical point of view, and the hopelessness of fitting equations to anything but the most elementary principles of the subject was recognized. In the ordinary modern turbine, with its combination of inward, downward and even outward flow in one wheel, the lines of action of the forces do not lie in a plane, and any detailed analysis becomes hopelessly unwieldly. There are, however, certain principles in the laws governing the impact of a liquid against a given surface, which are most valuable in indicating the line along which to work when designing, and which may save useless labor when following the "cut and try" method, and it is the aim to teach the general principles. Furthermore, a small turbine of a common commercial form is kept before the students who take it apart and reassemble it, in order that the application and limitation of the theories may be more clearly kept in view.

PRESENT CONDITION OF THE BRAZOS RIVER HARBOR WORKS.

In our issues of May 18 and June 22, 1889, and April 4, 1891, we described the work of harbor improvement at the mouth of the Brazos River, on the Texas coast, which was undertaken by the Brazos River Channel & Dock Co., under the direction of Mr. E. L. Corthell, Chief Engineer, and Mr. Geo. Y. Wisner, Resident Engineer. We are indebted to a correspondent who has kept close watch of the progress of the work for the following interesting account of its present condition:

In a paper read before the American Society of Civil Engineers, in November, 1891, by Mr. Geo. Y. Wisner, the history of the Brazos River harbor works was given up to that date. In conclusion the paper stated that until the jetties were thoroughly consolidated and strengthened with a proper concrete superstructure they would be in constant danger of being wrecked by storms, and could not be maintained in effective condition to give a much better channel than that then existing.

An examination of the harbor made by the U. S. Coast and Geodetic Survey, in December, 1891, showed the shoalest place in the channel across the bar to be about 15 ft. at mean gulf level. No authentic survey has been made since that date, but from the soundings made by the harbor pilots during the past summer it appears that practically no change has taken place in the depth on the bar during the past two years. On the outer slope, however, very interesting changes have occurred, which indicate that if the jetty works are ever carried to a successful completion, a much better harbor will be obtained than was originally expected by the promoters of the enterprise.

In 1881 the 20-ft. contour on the outer slope of the bar was about 4,500 ft. from shore. The big freshet in the river in March, 1889, pushed the bar seaward, so that the 20-ft. curve was 5,500 ft. from shore, and the material scoured from the channel during the jetty construction pushed the bar still farther seaward, until in July, 1890, the 20-ft. contour was over 7,000 ft. outside of the shore line.

During the past two years the erosion on the outer slope of the bar has been in excess of deposit to such an extent that the bar has receded shoreward over 2,000 ft., indicating that if the jetty works are ever completed out a distance of 4,800 ft., a 20-ft. channel will certainly be obtained and maintained.

As shown in the above-mentioned paper, engineering advice was dispensed with in 1891, since which time, although nearly enough money has been expended in repairs and in booming the town to have permanently completed the work, if properly expended, the jetties are not in nearly as good condition to-day as they were two years ago. The discusssion in 1889 showed that the outer 2,000 ft. of the jetties were from 1 to 3 ft. below mean gulf level, while at the present time it appears from the best information to be had that for about 4,000 ft. out the jetties are above mean gulf level; and from this point to their outer ends they are from 5 to 10 ft. below the water surface, or practically of no value for confining the current across the bar. Large amounts of money have been expended to boom the new town, but appearances rather indicate that the reaction from the attempt has done the place more harm than good.

There have been so many wild speculative harbor schemes on the Texas coast that the mere fact that a professional boomer is connected with an enterprise is sufficient to condemn it in the opinion of any careful investor.

In July, 1891, the first house was started in the new town of Velasco, four miles up the river from the jetty entrance. In the following December it had grown to a place of over 2,000 inhabitants, and at the public auction of lots that then took place choice lots were sold as high as $100 per front foot. It was generally understood by purchasers that the funds realized from this sale were to be expended in putting the jetties in a permanent effective condition. This expectation has not been realized, and as a result lot sales have been very light and the population has increased but little since that date.

A large cotton-seed oil mill has been constructed during the past summer, and from present indications it is probable that 50 or more steamers will clear for Europe with cotton and cotton-seed products during the coming winter.

Since 16 ft. is the maximum draft that a steamer can load to before going outside the bar, it is probable that the amount that will be expended during the season for lighterage would pay a dividend of over 20% on the amount needed to complete the jetties and open up the channel to a depth of over 20 ft. From an outside standpoint it certainly seems poor policy to allow such a state of affairs to continue.

Before this enterprise was started, Brazoria Co., in which the harbor is located, was practically bankrupt, but values of lands have since increased so much that the finances of the county are in good condition, and as the cost of lighterage across the bar is a direct tax on the producer, the people of this county alone can well afford to raise the funds to complete the improvement rather than to allow it to remain long in the present condition.

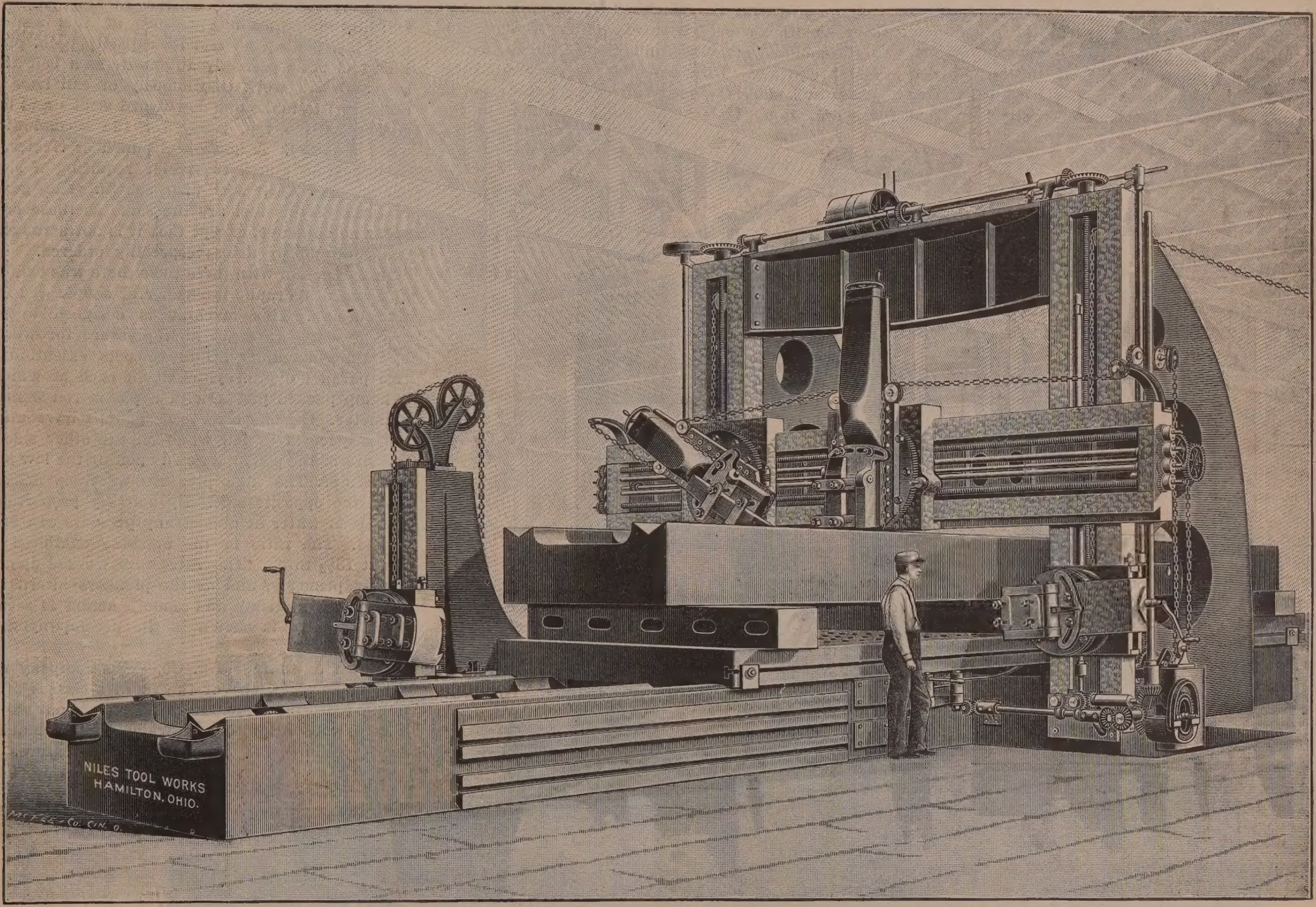
It is rumored that an attempt will be made during the coming winter to have Congress make an appropriation to either purchase the works or complete the construction. This, if so, cannot be otherwise than a dismal failure, for, as is well known, the original bill, in which no money was asked for, was nearly defeated by the opponents of the enterprise, and consequently, with the U. S. Treasury now practically empty and the oppposition much stronger than formerly, the chance for the passage of such a measure would not be one in a thousand.

THE MACHINE TOOL EXHIBIT AT THE COLUMBIAN EXPOSITION.

I.

General Machine Tools.

The very important part which foreign nations have played in making the Columbian Exposition at Chicago the success which it has been has often been commented upon, but so far as machine tools and special machines for working metals are concerned, the exhibit from the United States so far surpasses the combined display of all other countries as to make their individual exhibits seem almost insignificant. The competition in design and workmanship is thus confined almost wholly to American manufacturers, and is in no sense international. It is, perhaps, natural that this should be so, but it is also at the same time rather disappointing. In addition to the lessons always to be learned from such a comparison the American machinist at least may be pardoned for a curiosity to see how we compare with the older countries in a class of engineering design which they have often claimed as a field particularly their own.



PLANER, 12 FT. X 12 FT. X 30 FT., AT THE COLUMBIAN EXPOSITION. Niles Tool Works Co., Hamilton, Ohio.

Notwithstanding the magnitude of the display of metal working machinery by American manufacturers, however, it cannot be said to be complete in all respects. Some important classes of tools, especially hydraulic and pneumatic tools, are very meagerly represented. On the other hand, the application of the electric motor to well known types of tools is quite adequately shown by a number of examples. This is, perhaps, the feature which will most forcibly strike the machinist who remembers the tools at the Centennial exhibition, as in most respects the advance since that time has been by a series of almost imperceptible movements in the improvement of material and the workmanship of details, unnoted except by the close student of machine tool design. The most of these smaller improvements do not appear, of course, upon a superficial examination, but they have, perhaps, constituted the chief advance made by American manufacturers in the last two decades.

The multiplicity of machine tools for general work exhibited precludes any but a very general mention of the most important and interesting, and the many interesting special tools shown will have to be reserved for a separate article.

The Niles Tool Works.—On account of the great size of the tools shown this was, perhaps, the most striking exhibit of general machine tools at the exhibition. All of the tools exhibited were of massive size, and intended for the heaviest class of work, but chief among them may be mentioned a 12 × 12 × 30-ft. planer, a 6-ft. boring and turning mill and a 63-in. forge lathe. The planer is shown in the accompanying engraving, and is stated to be probably the largest ever built in the United States. Its weight is 150 tons, and, as stated, it can take work 12 × 12 ft. between the housings and 30 ft. long. The cutting speed of the table is 19 ft. per minute, and the return speed 50 ft. The table is a single casting weighing 35 tons. A noticeable feature of the table is that instead of the usual long T slots for fastening the work, it is provided with oblong square sided holes. The driving shafts run in brass bushings throughout the machine, and, in fact, this is the case with all the tools exhibited by the company. The belts are shifted by a patented device which moves but one belt at a time, and the table can be stopped and started instantly from either side of the machine. All the feeds are positive and take no power except when feeding.

Two of these planers have recently been built; one for the works of the General Electric Co., at Lynn, Mass., and the other, that on exhibition, for a large engineering concern in New York state.

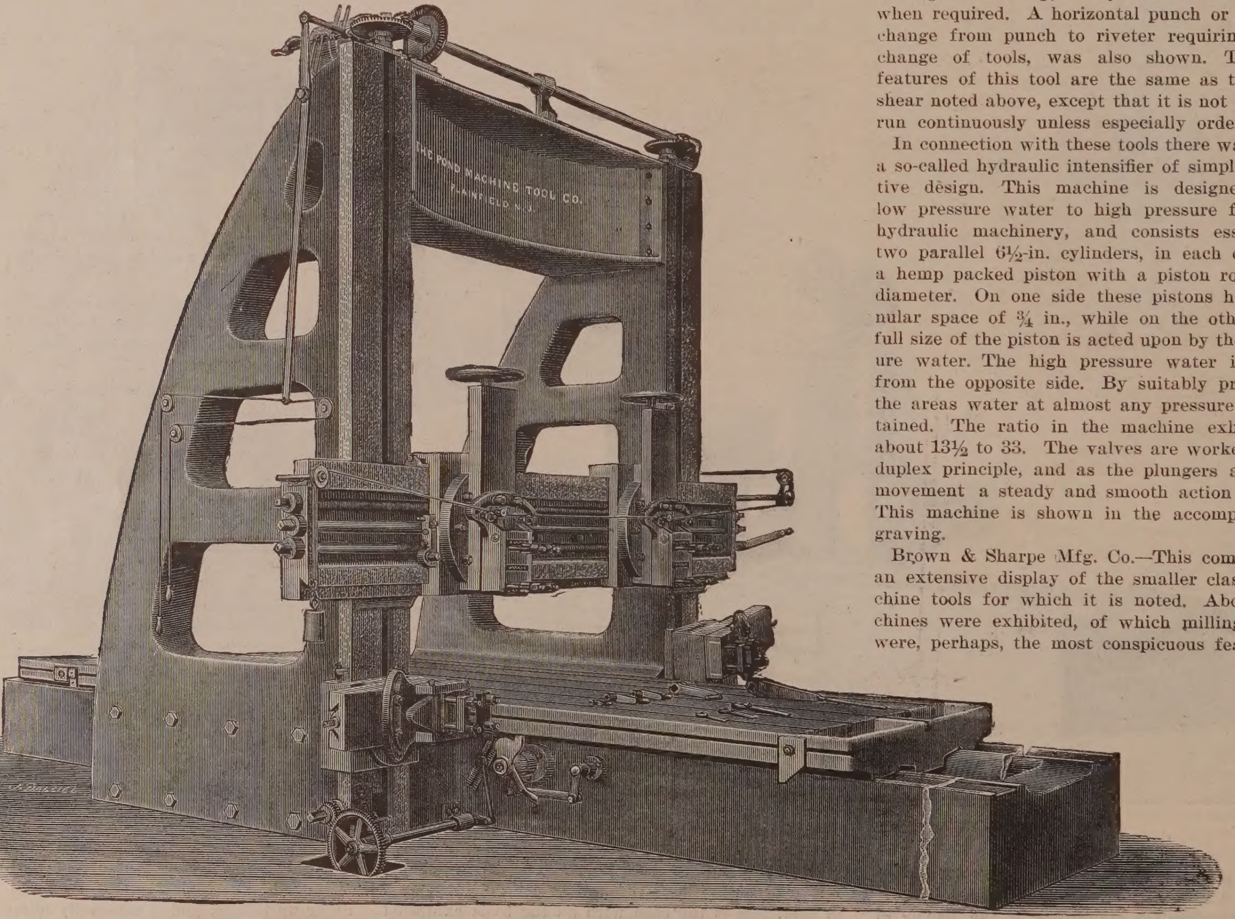
Of the two other tools mentioned, each was almost as massive in its way as the large planer. The 6-ft. boring and turning mill has a swing 73 ins. in diameter, and takes under the tool holders 36 ins. The boring bars have 24 ins. traverse and the range of feed is from 1-32 in. to 9-16 in. The cone has six steps for a 4-in. belt. The 63-in. forge lathe is designed for rough turning or finishing heavy shafts, rolls, cranks, etc. It swings, as stated, 63 ins. over the ways and 47½ ins. over the carriage, and will turn 20 ft. between centers. The cone is mounted on an independent steel spindle 10 ins. in diameter, with a 15-in. bearing. The spindle gears into the face plate. The cone has five steps and with two sets of back gears gives 15 changes of speed. Both of these tools and the planer were good examples of the heavier kinds of tools which are the firm's specialty.

Long & Allstatter Co.—In the same line of especially heavy tools may be mentioned the exhibit of this company and the Hilles & Jones Co., of Wilmington, Del. The latter company's exhibit will be considered in connection with the exhibit of Manning, Maxwell & Moore, in the World's Fair machine shop. The most novel of the tools exhibited by the Long & Allstatter Co. was a double angle shear mounted on a turntable and driven by a vertical shaft with bevel gears; the object of this arrangement being to permit the cutting of long bars without the necessity of removing them from the machine and turning them around, often a great convenience in a shop where room is limited. This shear will cut angles up to 7 × 7 × ¾ ins. at any angle up to 30°, and is especially adapted to bridge work. Its general appearance will be seen from the accompanying engraving. Four other machines were shown, one of which is a gang punch capable of punching 36 holes ¾ in. in diameter and 2 ins. apart. A boiler punch for punching up to 6 ins. diameter hand or flue holes in ¾-in. plate was also shown in operation. All of these tools had a thoroughly workmanlike appearance, being shown just as they were turned out of the shops, without any furbishing or decorating for "exhibition."

Manning, Maxwell & Moore.—One of the most complete exhibits of general machine tools at the Exposition was that shown in the World's Fair Machine Shop, equipped by Manning, Maxwell & Moore, of New York city. The exhibit comprised several different makes of machines, for which the company is general sales agent, and was located in an annex to the main hall, having a floor space of 95 × 125 ft. Among the various tools shown a line of lathes and planers manufactured by the

Pond Machine Tool Co., of Plainfield, N. J., deserve especial mention. The largest planer exhibited was 10 × 10 × 25 ft., only a little smaller than the large planer exhibited by the Niles Tool Works mentioned above, and is shown in the accompanying cut. A peculiarity of this planer is that the table travels on two ways, one of which is the usual V-shape, but more shallow than usual, and the other of which is flat. The object of this construction is to provide for the sidewise expansion and contraction of the table.

The lathes exhibited comprised a 54-in. engine lathe, car axle lathes and two locomotive driving wheel lathes, the last being in a separate exhibit in Machinery Hall proper. The driving wheel lathes will take wheels up to 42 ins. and 79 ins. diameter, respectively. In the same connection may be mentioned a powerful hydraulic press for forcing driving wheels onto their axles. This machine has a capacity of 200 tons. The ram is 12 ins. in diameter and the power is furnished by two double action plunger pumps; one of which gives quick work up to 50,000 lbs. and the other slow work up to 400,000 lbs. The engine lathes exhibited were peculiar in respect to the position of the spindle, which is not placed centrally over the ways, but nearer the back of the bed by from 4 to 5 ins. The object of this is to increase the rigidity of the machine when working large diameters, the tool post being by this arrangement, directly over one of the ways instead of outside the ways and over the apron as would be the case with a centrally located spindle. Among the other tools of the Pond Machine Tool Co. shown here were a 6-ft. boring mill, a car wheel boring machine, a 6-ft. radial drilling machine, and a number of punching and shearing machines.


THE POND MACHINE TOOL CO.
PLAINFIELD N.J.

PLANER, 10 FT. X 10 FT. X 25 FT., AT THE COLUMBIAN EXPOSITION. Manning, Maxwell & Moore, New York City.

Another noticeable machine shown in the shop was an electrically driven, combined punch and shear, manufactured by Hilles & Jones, of Wilmington, Del. It could punch a 1-in. hole in a 1-in. plate, 25 ins. from the edge. The main exhibit of this company in Machinery Hall proper, comprised a good display of heavy punching, shearing and other tools for working plate and sheet metal. Perhaps the most interesting of these were an independent engine-driven double angle shear, each knife being independent, and a plate planer, with a built-up iron clamping beam instead of the usual cast iron beam. On the lower member of the beam were eight little trolleys carrying inverted jacks, which are used to clamp the work instead of the old form of clamping screw working through the beam. A great advantage of these movable jacks is that they can be distributed or collected at any point on the beam as the work demands. The exhibit also included an independent engine shear or punch with an 18-in. throat, which was capable of punching 3-in. holes in 2-in. steel plate or of shearing steel bars 4 ins. square. Knowing the strong tendency of the average sightseer to "feel" of things, the signs of danger posted conspicuously on some of these machines in operation struck one with grim amusement when he thought of the certain fate of any inquisitive finger and the surprised anguish of its owner.

Before leaving the Machine Shop exhibit, however, mention should be made of the Tabor automatic molding machine for making sand molds for metal castings. This machine was operated by steam and made the entire mold, drag and cope, in one operation. It is to be noted also that in the connecting blacksmith shop was the only steam hammer of American manufacture at the Exposition, so far as could be discovered, excepting, of course, the model of the enormous hammer of the Bethlehem Iron Co., in the Manufactures Building. This hammer was manufactured by the Morgan Engineering Co.

R. D. Wood & Co.—Such of the exhibits of this company as come under the head of tools deserve especial mention as being the only hydraulic sheet metal working tools at the Exposition, as far as a pretty thorough search disclosed. The tools shown comprised riveters, punches and shears of various capacities, and both fixed and portable. Two of the smaller portable riveters known as the "parallel" and "bear" types, were usually interesting as showing the easy handling and flexibility for various uses of such tools. In the "parallel" riveter the cylinder and ram are placed in slides at the back and the two jaws come together in a straight line parallel to the center line of the rivet instead of in a circular line, as is the case where the jaws swing on a trunnion. As there is no loss due to unequal lever arms, a much smaller cylinder is required to secure a given pressure. The "bear" riveter shown was chiefly interesting for its hanging gear which permitted a universal action of the punch, by the use of a single arm. This riveter was also provided with a hydraulic hoisting and lowering device.

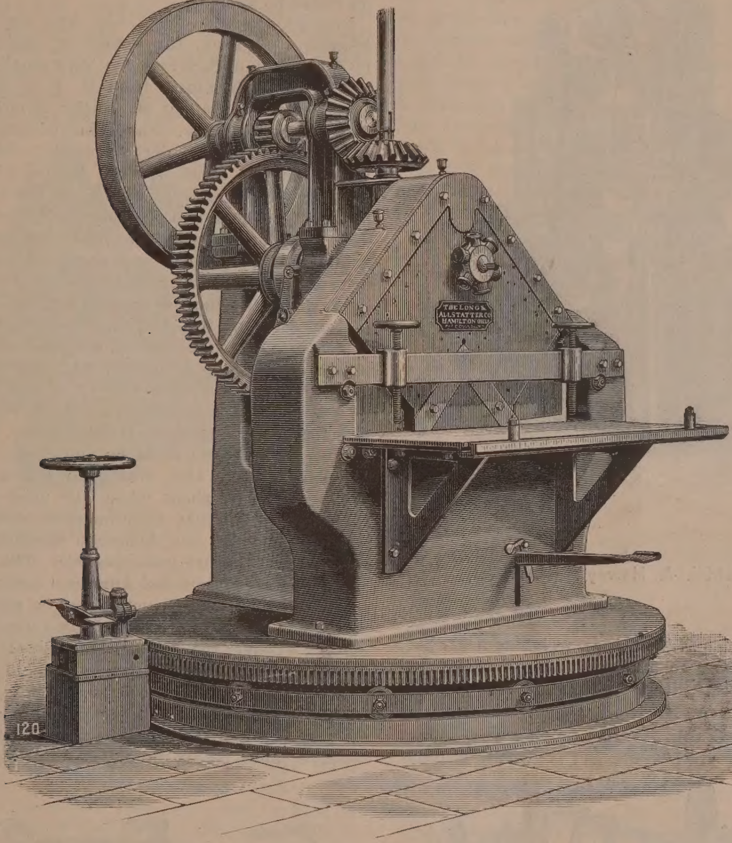
Among the larger machines shown was a 70 tons capacity plate closing riveter with an 8-ft. gap. This tool is automatic in its action, and so arranged that it will close the plates together, while the rivet is being upset, with a pressure of 30 tons, the rivet, meanwhile, being headed down with a pressure of 40 tons, and at the proper moment the plate pressure is removed and thrown on the rivet automatically. Another powerful tool was an automatic hydraulic shear with a 1,000-lb. crane attached. The working pressure of this shear is 1,500 lbs. per sq. in. and its capacity ⅞-in. plates. This tool is as perfectly automatic as a belt-driven tool and will work continuously or can be so arranged as to make one downward stroke and back, resting at the top, ready for the second stroke when required. A horizontal punch or riveter, the change from punch to riveter requiring a simple change of tools, was also shown. The general features of this tool are the same as those of the shear noted above, except that it is not arranged to run continuously unless especially ordered.

In connection with these tools there was exhibited a so-called hydraulic intensifier of simple and effective design. This machine is designed to raise low pressure water to high pressure for working hydraulic machinery, and consists essentially of two parallel 6½-in. cylinders, in each of which is a hemp packed piston with a piston rod 5 ins. in diameter. On one side these pistons have an annular space of ¾ in., while on the other side the full size of the piston is acted upon by the low pressure water. The high pressure water is delivered from the opposite side. By suitably proportioning the areas water at almost any pressure can be obtained. The ratio in the machine exhibited was about 13½ to 33. The valves are worked upon the duplex principle, and as the plungers alternate in movement a steady and smooth action is secured. This machine is shown in the accompanying engraving.

Brown & Sharpe Mfg. Co.—This company made an extensive display of the smaller classes of machine tools for which it is noted. About 40 machines were exhibited, of which milling machines were, perhaps, the most conspicuous feature. Sixteen of these machines were shown, including the original universal milling machine patented by Mr. Jos. R. Brown in 1867. A study of this machine, in comparison with some of the latest millers manufactured by the company, shows how thoroughly the essential features of the milling machine as it is now constructed had been conceived and embodied in the prototype. Five of the machines shown were of new design, and were exhibited for the first time. Their new features were chiefly in connection with the feed and the spiral head.

Other noteworthy tools exhibited were a universal grinding machine and an automatic gear cutting machine, the latter connected for operation. This cutter is automatic and is capable of cutting a tooth on a gear wheel of 3 diametrical pitch and 6 ins. face at the rate of 5 ins. per minute.

Another machine which deserves especial mention, and was here publicly exhibited for the first time, is the measuring machine used in the company's shops to determine the accuracy of standard gages and other articles that must be finished to exact size. On this instrument readings may be obtained to 0.00001 in., and readings may be made of variations not exceeding 0.0005 in. In this same connection of securing accurate workmanship may be mentioned a 36 × 68-in. master surface plate exhibited. A feature of all the machines exhibited was the accurate workmanship of all important parts. The cylindrical bearings are accurately ground, the plane bearings scraped to surface plates and all important screws accurately cut.



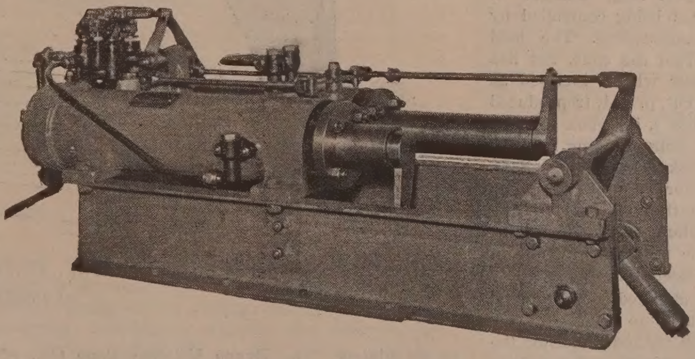
ANGLE-IRON SHEAR, MOUNTED ON TURNTABLE, AT THE COLUMBIAN EXPOSITION.
The Long & Allstatter Co., Hamilton, Ohio.

In addition to the machine tools shown the company, together with Darling, Brown & Sharpe, displayed several showcases of small tools, about 1,500 in number, without duplicates. These comprised a multiplicity of general and special cutters, calipers, scales, gages, etc. The largest milling cutter shown, and, it was stated, perhaps, the largest ever manufactured, was 9 ins. in diameter and 24 ins. long. Instead of being continuous the cutting edges of this cutter are cut by flat notches, this, it is stated, enabling the tool to cut more freely than would be the case with continuous edges. Some of the special cutters shown were of most intricate shapes, and the samples of work from them astonishing in their perfection.

Pratt & Whitney Co.—Like the Brown & Sharpe Mfg. Co., this company exhibited a line of standard tools mostly of small size, and most of them familiar to machinists. The exhibit was chiefly interesting, therefore, as an exhibition of general machine tools and machine tool work from a representative American manufacturer, although several new machines are shown which will be noted further on. The tools exhibited were taken from the regular stock of the firm and as such represent regular practice. The point brought out above that progress in machine tool construction had been of late years along the line of better material and more accurate workmanship on details was nowhere better exemplified than in the exhibits of these two companies, although the improvement is by no means confined to these two companies or the class of machines which they build, but was as evident in the brass bushings for the driving shaft of the great planer shown by the Niles Tool Works. An examination of the tools shown by the Pratt & Whitney Co. showed for, example, all spindles and actuating screws of steel, all journals run in cast iron boxes lined with Babbitt metal. Nuts, screws and wrenches were case-hardened; sliding surfaces were scraped to an accurate bearing; driving cones were finished inside as well as outside to balance them and insure steadiness at high rates of speed; ball-bearing collars were provided to take the thrust of worm gearing and insure easy running, etc.

Among the machines exhibited which possessed some new features were a column miller, a 19-in. facing and chucking machine and a roll grooving machine for grooving chilled iron rollers for flour mills. Mention may also be made of the rifling and gun barrel boring machines.

Detrick & Harvey Machine Co.—The exhibit of two of the "open side" planers of this company in operation attracted much attention on account of the novelty of their design. One of these planers is shown in the accompanying illustration and it will be seen from this that the usual two-post and cross bar housing is replaced by a single post carrying an arm for the cutter, thus leaving one side open and allowing much larger work to be planed than could be handled on the ordinary form of planer with the same size of table. As an example, it is stated that on a 48 × 36-in. machine, a planer post 13 ft. 6 ins. high, 8 ft. wide and 3 ft. deep, weighing 20,000 lbs., has been planed on all sides. At first sight it would seem that the vibration of the tool at the end of the arm in taking deep cuts would be objectionable, but a more thorough examination shows that the construction of the arm and post connections are extremely strong, and, in fact, the builders claim less vibration than at the center of the beam of a two-post planer. The machine in operation certainly showed as clean a cut and as little vibration as could be asked for. These planers are built in seven sizes, from 30 × 30 ins. to 72 × 72 ins., with four lengths of table for each size, except the largest, where the table is built any length desired. For many pieces of irregular work these planers appear to possess considerable advantages over the usual form.



AUTOMATIC HYDRAULIC INTENSIFIER AT THE COLUMBIAN EXPOSITION.
R. D. Wood & Co., Philadelphia, Pa,

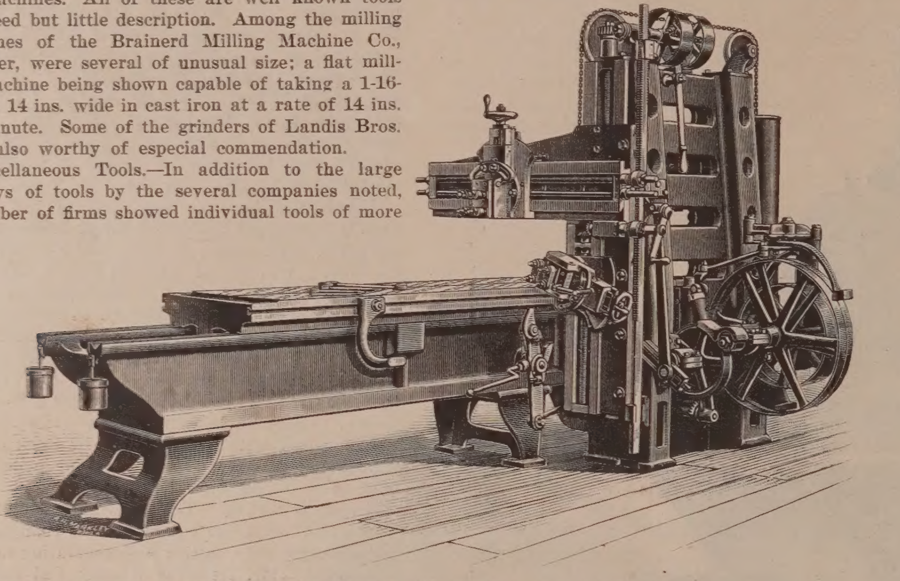
Gisholt Machine Co.—This company had an unusually interesting exhibit of turret lathes of various sizes. The largest of these had a swing of 30 ins., and a traverse of turret of 54 ins. This machine is a good example of the attention which American manufacturers pay to the smallest details in securing celerity and convenience of operation. It is hard to conceive of many more adjustments being applied to a single machine, than was the case here. Six of these lathes were shown, varying in size and somewhat in construction, together with samples of their work ranging from small screws and bolts to cone pulleys and back gear blanks for 30-in. lathes.

Warner & Swasey.—The tool which attracted the most attention in the exhibit of this company was the ingenious gear cutting and generating machine designed by Mr. Ambrose Swasey and exhibited in operation. This tool was fully described by the inventor at the Richmond meeting of the American Society of Mechanical Engineers in 1890, and we refer such of our readers as may not be familiar with it to this description published in the proceedings of that society for 1890. There were also shown a number of other tools, including vertical milling machines, monitor lathes, revolving turret screw machines, etc., and an automatic valve boring and tapping machine which will be more fully noted in another article on the special tool exhibits at the Exposition. In addition to the company's tool exhibit in Machinery Hall, it also showed the great 40-in. Yerkes telescope for Chicago University and other astronomical instruments in the Manufactures Building.

Lodge & Davis Machine Tool Co.—The silver and gold plated "toolroom" lathe which occupied a prominent place in this exhibit proved a drawing card, to the general public at least, and undoubtedly served its object, viz., to attract attention to the rest of the machines in the exhibit. These comprised several engine lathes, each with the lead screw inside the bed directly beneath the inside V, which is a feature of this company's lathes, four radial drill presses, one an especially handsome universal machine, two planers 24 ins. and 30 ins., respectively, cabinet turret lathes, screw machines, milling machines, etc. All of these tools showed careful workmanship and good construction in the phosphor bronze journal bearings, hardened steel thrust bearings, hollow steel spindles ground to bearings, and good solid beds and head and tail stocks, despite their rather "for exhibition" appearance due to an elaborate superficial finish. In the lathes particularly great care has been shown in arranging all movements to be controlled from the apron. The inside lead screw by which a central pull is obtained on the carriage, and the tendency to twist in taking a heavy cut is obviated, is also a good point.

Hill, Clark & Co.—This company made a large display of general tools of various manufacture, for which they are sales agents, including more particularly a number of Flather lathes and planers, Brainerd milling machines and Landis Bros. grinding machines. All of these are well known tools and need but little description. Among the milling machines of the Brainerd Milling Machine Co., however, were several of unusual size; a flat milling machine being shown capable of taking a 1-16-in. cut 14 ins. wide in cast iron at a rate of 14 ins. per minute. Some of the grinders of Landis Bros. were also worthy of especial commendation.

Miscellaneous Tools.—In addition to the large displays of tools by the several companies noted, a number of firms showed individual tools of more than usual interest and merit, and there were also several large displays of machinists' and hand tools, drop forgings, etc.



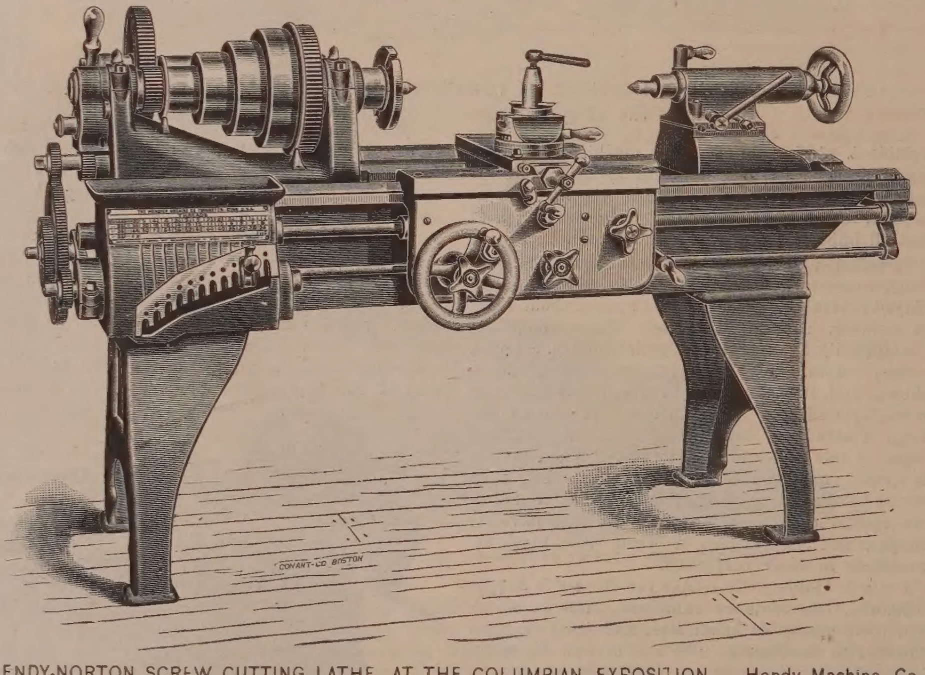
OPEN SIDE PLANER, AT THE COLUMBIAN EXPOSITION. Detrick & Harvey Machine Co., Baltimore, Md.

Of the larger individual tools one of the most novel was the 16-in. friction driven engine lathe exhibited in operation by the W. F. & John Barnes Co., Rockford, Ill. The distinctive feature of this tool consists in the elimination of the cone pulley and the substitution of the friction driving device shown in the accompanying illustration (pp. 411). Two friction wheels, one for reverse and the other for forward motion, occupy the place of the cone and bear against a belt-driven friction disk. By the lever shown the right-hand wheel can be swung toward the circumference or the center of the disk, and its speed is thus varied. The face of the disk and also of the wheels are covered with ordinary leather. It is claimed that the driving power is fully as great as with cone pulleys and that the tool is much superior in convenience of handling.

Another lathe showing quite an innovation in feed gear was shown by the Hendey Machine Co., of Torrington, Conn. The novelty in this machine is the avoidance of the usual large number of change gears, the rate of feed being controlled by the device shown in the engravings. The lead screw is not driven direct from the cone, but has fastened to it a cone of spur wheels inclosed as shown in the accompanying cut, p. 411, (reproduced from the "American Machinist"), in a box for protection. Below this cone of spurs running in bearings at the bottom of the box is a driving shaft. This shaft has a long feather running from end to end of it, and on this feather slides a driving gear which can be moved along the shaft by the handle shown and thus made to drive any one of the spur wheels. It will be seen that the pitch of the screw to be cut can be changed very quickly, the spur wheels being arranged to permit all the usual pitches of from 6 to 20 without altering the train of gearing between the spindle and the driving shaft. By changing this gearing, however, other pitches can be cut, two changes only being required to cut all pitches of from 1½ to 80 threads. To further facilitate the operation of screw cutting, the shaft carrying the driving gear for the lead screw is driven by bevel reversing gear, the change being effected by the small handle shown at the right of the carriage. By its use the direction of the travel of the carriage can be instantaneously reversed without stopping the lathe or altering the motion of the spindle.

Another tool which attracted much attention was a shaper exhibited by the Morton Mfg. Co. Instead of cutting the work on the out stroke, as with ordinary shapers, the cut is made on the return, and thus the tendency is to pull all bearings together instead of to push them apart. The effectiveness of this arrangement will be seen when it is stated that this 24-in. shaper, weighing 5,000 lbs., showed its ability to take with ease cuts 1¾ ins. broad in cast iron with a feed of 1-13 in.

A. D. Quint, of Hartford, Conn., exhibited his six-spindle turret drill for light tapping work, which possesses many good points, but is already familiar to machinists. The Evans Friction Cone Co., of Boston, Mass., showed their well known friction cone countershafting, and E. Horton & Sons exhibited a large variety of their car wheel chucks, patent drill chucks and improved independent chucks.



HENDY-NORTON SCREW CUTTING LATHE, AT THE COLUMBIAN EXPOSITION. Hendy Machine Co., Torrington, Conn.

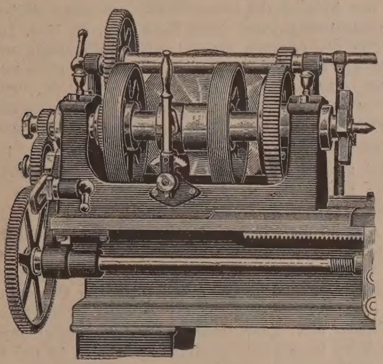
Mention has already been made of some of the small tools exhibits. Both the Morse Twist Drill Co. and the Cleveland Twist Drill Co. had interesting displays of drills, reamers and other small tools attractively arranged in showcases. A handsome exhibit of twist drills, reamers, etc., was also made by the Standard Tool Co. A series of drills arranged in order of size was especially effective. At one end of the series was a twist drill weighing 193 lbs., 6 ins. in diameter and 32 ins. long, and at the other a No. 80 drill 0.013 in. in diameter. Billings, Spencer & Co. showed a fine line of drop forgings in iron, steel and bronze, some of most intricate shape, varying from 50 lbs. to a fraction of an ounce in weight.

Foreign Machine Tools.—As was stated in the opening paragraph, the exhibit of machine tools by foreign manufacturers was very small. A number of steam hammers from B. & S. Massey, of Manchester, was about all worthy of mention that England had to show. These showed several points of difference from American design, chief among which may be mentioned the frames which were castings with flanges instead of the box form usual in American hammers, it being considered easier to detect casting flaws in this form. By far the best exhibit of foreign tools was made by the German firm of J. E. Reinecker, of Chemnitz, an especially interesting machine for backing milling cutters being chief among its exhibits. The Gaggenau Iron Works, of Gaggenau, showed a good line of shapers of various sizes and designs, and Heimer & Ehrhardt, of Duesseldorf, a variety of cold saws, one of which had a universal horizontal movement and was driven by a Siemens-Halske motor. The only French exhibit was made by the Societe Dandoy-Mailliard, Locq & Cie., Maubeuge, which showed a variety of tools, about which the most noticeable feature was, perhaps, their inconvenience in every respect in which an American machinist would consider convenience indespensable. The Canadian tools so nearly approached American designs in most essentials that it is something of a misnomer to call them foreign. Of the three Canadian firms making exhibits the London Machine Co. had, perhaps, the most interesting exhibit in its large "break lathe." In this tool the bed is in two parts joined by bolts and T-slots which permit of a movement endwise of about 4 ft., which allows for this distance much larger diameters to be turned than can be handled on the other part of the machine, the respective swings being 62 ins. and 38 ins.

CONSTRUCTION OF PIVOT PIER, INTERSTATE BRIDGE, OMAHA, NEB.

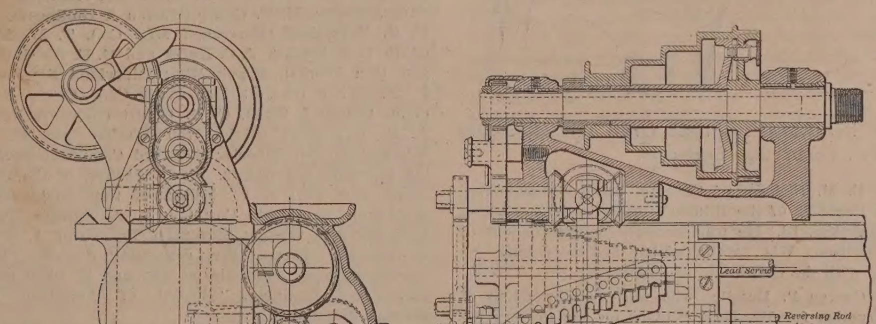
We illustrate in the accompanying cuts details of the caisson for the pivot pier of the 520-ft. swing span of the Interstate Bridge now being constructed between East Omaha, Neb., and Council Bluffs, Ia., by the Omaha Bridge & Terminal Ry.

Co. When completed the Interstate Bridge will provide for two railway tracks, two roadways for the use of electric cars and other vehicles, and two sidewalks; but at present, as only the swing span is completed, the traffic has to be accommodated by a temporary bridge connecting with the swing span. The line of this temporary bridge makes a slight angle with that of the permanent structure so as not to hinder work on the new structure. As the swing span is now swung for the temporary bridge, this different alinement will, of course, necessitate it being reswung when the permanent structure is completed. As we expect to give full details of the swing span in a future issue, no further mention will be made of it here except to note that it is the longest span of the kind in the world, being 15 ft. longer than the swing span of the Thames River bridge at New London, Conn. (Eng. News, Oct. 12, 1889).



Head of 16-in. Friction Driven Engine Lathe, at the Columbian Exposition. W. F. & John Barnes Co., Rockford, Ill.

The general design of the steel caisson, upon which the pivot pier is founded, is shown in the second accompanying cut (pp. 412). It sunk 115.9 ft. below low water and rests on a compact bed of boulders, overlaying the solid rock, which is about 120 ft. below low water. The outer shell of the caisson is 40 ft. in diameter, and the inner shell contracts from this diameter, at which it unites with the outer shell to form the cutting edge, to the dredging cylinder, 20 ft. in diameter, thus forming a dredging chamber 10½ ft. high, whose walls are the surface of the frustum of a cone. The shells of the caisson are made of steel plates ½ in. thick, butt-jointed and joined together by splice plates 7 ins. wide and single riveted. The cutting edge is reinforced by two bands, one on the outside 18 ins. wide and one on the inside 6 ins. wide, both being 1 in. thick. Between the shells and riveted to them at the radially coincident joints of the plates of each are plate diaphragms, built up of ½-in. web plates and 4×4×½-in. flange angles in pairs. There are 20 of these diaphragms, and they extend to the height of 10½ ft. above the cutting edge. Directly above these is a horizontal lattice girder ring riveted to the interior dredging cylinder at its lower end and to the exterior cylinder at the same horizontal plane. The flanges of this girder are each built up of a plate 18 ins. wide by ½ in. thick, and two angles 6×4 ins., weighing 42 lbs. per yd. The lattice angles are in pairs and are 6×4 ins., weighing 50 lbs. per yd.



DETAIL OF DEVICE FOR CHANGING PITCH IN HENDY-NORTON SCREW CUTTING LATHE.

The caisson proper is 16 ft. high. Above this the two cylinders extend a height of 100 ft., making a total of 116 ft. from the cutting edge to the top of cylinder. The cylinders above the caisson are of ⅜-in. steel plates jointed as in the caisson. As struts there extend between the cylinders 8×8-in. timbers resting on and bolted to angle brackets which are riveted to the shells. There are also supplied tension turnbuckle rods of 1¼-in. iron, bolted to pairs of 4×4×⅜-in. angles riveted to the shells. The rivets in the cutting edge are 1 in.; all others are ⅞ in. A system of 3-in. jet pipes, 20 in number, open into the dredging chamber near the cutting edge, being reduced to 1 in. at that point. These pipes embedded in the concrete are carried vertically to the top of the cylinder. At intervals of 10 ft. a connection is made from each pipe through the outside shell to the exterior of cylinder by means of a ¾-in. pipe. This system of jets was for the purpose of reducing frictional resistance and controlling the descent of the caisson.

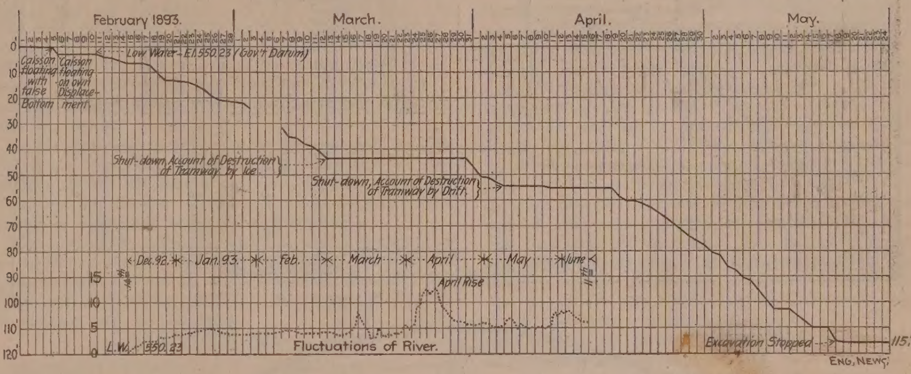


DIAGRAM SHOWING PROGRESS IN SINKING STEEL CAISSON FOR PIVOT PIER OF INTERSTATE BRIDGE.

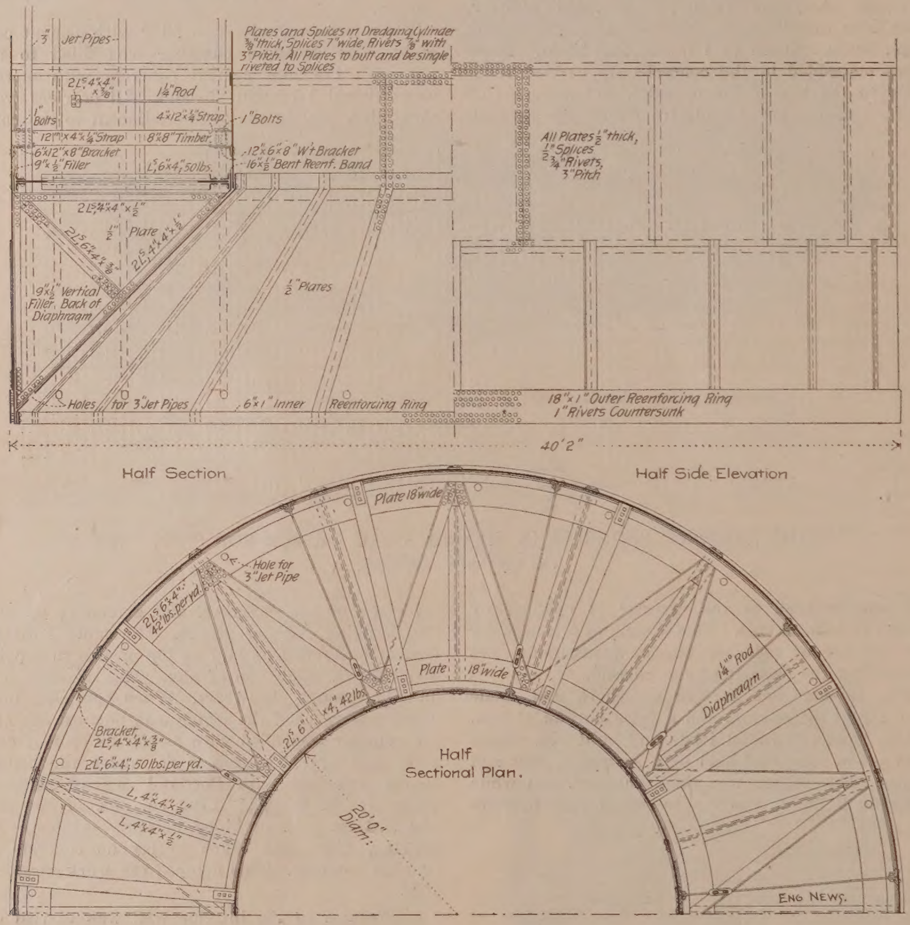
The caisson was erected on shore and made water tight by calking, and a false bottom of 3-in. plank, spiked to radial joists and built in sections, was put in place and held by a system of rods and struts. The caisson was then launched, and while drawing 3 ft. of water was towed into position through a passage cut in the ice. Upon the false bottom being removed, the caisson drew 6½ ft. on its own displacement. Work was begun at once; concreting, building up cylinders and dredging out the interior well. Up to the girder ring the space between the shells was filled with Portland cement concrete, the mortar proportions being 2½ sand to 1 cement. From this point up to 3 ft. from the top of the cylinder (113 ft. from the cutting edge), the annular space was filled with Louisville cement concrete, the mortar proportions being 1½ sand to 1 cement. In this concrete layers of carefully selected rubble were embedded. The stones were separated from each other by at least 6 ins. of concrete. The top 3 ft. of the annular space was filled with Portland cement concrete of the same proportions as that used near the cutting edge.

Directly on the concrete, within the annular space and at a point 116 ft. from the cutting edge, was built the masonry shell of the pier, the masonry being carried up as the cylinder sank below the water. An interior cofferdam of steel, built as a continuation of the dredging cylinder, was carried up with the masonry and served to securely hold the backing while the dredging well was unchanged. The masonry pier is built of Kettle River (Minn.) sandstone backed by concrete. It is 38 ft. diameter, and is surmounted by a belting course 39 ft. diameter and a coping covering the entire top 40 ft. in diameter. The height of the masonry from the top of the cylinder to the top of the coping is 18½ ft.

The interior cylinder was filled with cement concrete. The dredging chamber was filled to the top with Portland cement concrete with mortar proportioned 1 cement, 2 sand. All crevices were thus filled, sealing the spaces adjacent to the conical walls of the chamber, and extending up into the dredging cylinder proper. The same Portland cement concrete was laid on top of this to a point about 50 ft. below top of pier. This concrete was all laid through the water. When the point indicated was reached the water was pumped out and the cylinder was filled with Louisville cement concrete laid dry. The top 5 ft. under the coping course was laid with Portland cement concrete. There are in the pier 5,792 cu. yds. of concrete and 376 cu. yds. of stone masonry, exclusive of backing. Care was taken to lay no concrete in freezing weather. This delayed the work considerably.

Excavation in the interior well was carried on mostly by means of a clam shell dredge bucket, supplemented by hydraulic excavators. The material passed through for about 50 ft. below low water was fine river sand mixed with clay, and carrying a large amount of river debris, pieces of lignite, etc. A number of heavy logs, which considerably retarded the sinking, were encountered and taken out. At a depth of 50 ft. the material changed to clean, coarse sand, with occasional small boulders. This material continued to a point about 6 ft. above bedrock, where a compact bed of large boulders was encountered. During the sinking the caisson was kept level and in position as well as assisted in its settlement by the use of the jet pipes built up with the cylinders and of auxiliary jets. The extreme severity of the winter and the heavy April rise of the river rendered the prosecution of the work difficult.

Preliminary work was begun about Nov. 15, 1892, and the erection of the caisson began Dec. 13, and it was launched after considerable delay, Jan. 30, 1893. The severest weather of the winter was experienced immediately after this, and it was not until Feb. 10 that the caisson was forced into exact position, floating on its own displacement. On Feb. 10 concreting was begun and the caisson gradually settled on bottom. On Feb. 15 excavation was begun and from that date sinking was steadily prosecuted, being retarded somewhat by the logs encountered and by the necessity for cautious excavation until the caisson became firmly embedded in the river bottom. During the period until March 12, the average rate of settlement was about 1½ f in 24 hours. On March 12 the ice in the river went out, carrying with it the temporary tramway between the shore and pier. Stoppage of work was thus necessitated, and the subsequent condition of the river did not permit the renewal of work until March 31. Sinking had only been resumed for a few days when, on April 5, the tramway was for a second time carried out by the drift which filled the river during the unusually heavy April rise. The tramway was replaced as soon as possible, and work was recommenced April 19. From this date sinking was continued without serious interruption until the caisson reached its final position on May 24. During this period the average rate of settlement was 2 ft. per day.



CAISSON FOR PIVOT PIER OF 520-FT. SWING SPAN OF INTERSTATE BRIDGE OVER THE MISSOURI RIVER, OMAHA, NEB. Sooysmith & Co, Contracting Engineers.

The progress of the sinking is shown graphically in the accompanying diagram. The filling of the interior of the caisson and dredging cylinder was begun on May 25, and was carried on in the manner already described. The pier was completed and turned over to the superstructure contractors on June 13, 1893.

Sooysmith & Co., Mills Building, New York city, were the contractors for this pier. The Chief Engineer of the bridge is Mr. J. A. L. Waddell, M. Am. Soc. C. E., of Kansas City, Mo. The Phoenix Bridge Co., Phoenixville, Pa., are contractors for the swing span.

PERSONALS.

Mr. Gustavus Viebahn has been appointed City Engineer of Watertown, Wis.

Mr. John T. Gerry, Superintendent of the Burlington & Western and the Burlington & Northwestern railways, died at Burlington, Ia., last week, at the age of 50.

Mr. De Guree, who was engaged to prepare plans for the west end sewer system of Windsor, Ont., has resigned, the council having appointed Mr. William Newman as City Engineer.

Mr. Warner Miller has resigned his position as President of the Nicaragua Canal Construction Co. Capt. Davis, Vice-President, has also resigned, and Mr. Smith M. Weed has been elected to succeed him.

Mr. Robert I. Sloan, M. Am. Soc. C. E., has been engaged as Chief Engineer of the Lake St. elevated railway, of Chicago. He has been for the past two years Chief Engineer of the Chicago & South Side elevated railway.

Mr. Sumner Collins, General Superintendent of the Louisville, New Albany & Chicago, has resigned, to accept a similar position on the Wisconsin Central, with headquarters at Milwaukee.

Mr. George M. Rose, of St. Paul, Minn., died of pneumonia at Chicago, Nov. 12, while on a professional visit to that city. He was well known in England as well as in this country as a designer of blast furnaces and iron foundries.

Mr. E. M. Nichols, of Chicago, has been appointed Chief Engineer of the Illinois Hospital for the Insane, at Kankakee, Ill. He was formerly Superintendent of the Madison, Wis., water-works, and was until recently with the Crane Co., of Chicago.

Mr. George P. Hamlin, who was Superintendent of Construction for Mr. Ross Winans on the railway between St. Petersburg and Moscow, died in Baltimore, Md., Nov. 12. He served as machinist's apprentice to Mr. Winans, and went to Russia when the latter took the contract for the St. Petersburg and Moscow line.

SOCIETY PROCEEDINGS.

BOSTON SOCIETY OF CIVIL ENGINEERS.—At the meeting on Nov. 15, the president, Mr. John R. Freeman, in the chair, and about 75 members and guests present, a paper entitled "Notes on Water-Power Equipment," by A. W. Hunking, was read by the secretary in the absence of the author.

Mr. Berger, of the firm of Buff & Berger, of Boston, then gave an interesting talk, upon certain special features of design in the engineering instruments made by his firm, and of the reasons which had led to these designs. A number of instruments were exhibited. In regard to aluminum instruments, Mr. Berger stated it as his belief that the engineer who was anxious for a very light instrument would do better to select a small instrument of brass than a large one of aluminum, and stated it as his belief that fully as high precision could be obtained with the 5-lb. brass transit with a 4-in. circle as could be obtained with a full sized transit made chiefly of aluminum. The fact that aluminum expanded about twice as much as brass for a given increase of heat was against it, as was also its lack of rigidity. (Eng. News, Nov. 2, 1893.)

At the next meeting Dec. 20, a series of papers and discussions will be begun upon the best organization and methods for the administration of a city engineer's office. Brief experience papers from prominent municipal engineers are promised upon office records and indexes, the making and keeping up to date of assessors' and other maps, management of street work, standard methods of arranging intersections on heavy grades and a variety of other topics connected with municipal work.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.—The first regular meeting of this society, the youngest of our national engineering societies, was held at the house of the American Society of Mechanical Engineers, New York city, on Nov. 16 and 17. The first session opened with an address by the President, Mr. Clement A. Griscom, of Philadelphia, President of the International Navigation Co. The report of the Executive Committee was presented by the Chairman, Naval Constructor Francis P. Bowles. The number of persons elected to membership in the several grades now stands as follows: Life members, 4; life associates, 4; members, 260; associates, 165; juniors, 2; total, 435. Of this number all save 22 members and 15 associates have become fully qualified by the payment of dues and the performance of other acts specified by the constitution. The society's exchequer is in excellent condition. Since the organization of the society the total receipts from membership dues, etc., have been $5,404. The total expenditures have been $768, leaving $4,636 cash in the treasury. Following this the names of three new members, one associate and one junior, were voted on, and the president appointed a nominating committee to report the names of officers for the ensuing year. Later in the session the committee reported a list of officers, which was substantially the same as that under which the preliminary organization has been carried on. The principal officers are: President, Clement A. Griscom, Philadelphia, President International Navigation Co.; First Vice-President, Theo. D. Wilson, Washington, ex-Chief Constructor U. S. N.; Secretary and Treasurer, W. L. Capps, Asst. Naval Constructor U. S. N., Washington; Vice-Presidents, Messrs. Chas. H. Cramp, Geo. W. Melville, Geo. W. Quintard, Irving M. Scott, Francis A. Walker and Wm. H. Webb, to which list were added Messrs. Philip Hichborn, Chief Constructor U. S. N.; Chas. Loring, ex-Engineer in Chief U. S. N., and Commodore R. W. Meade, U. S. N. The council of the society is constituted as follows: From the Navy, Messrs. Francis T. Bowles and F. L. Fernald, Naval Constructors U. S. N.; Commander F. E. Chadwick and Commodore W. P. Sampson, Chief of the Bureau of Ordnance; from the shipyards, Messrs. H. T. Gause (Harlan & Hollingsworth), N. G. Herreshoff (Herreshoff Mfg. Co.), T. W. Hyde (Bath Iron Works), J. C. Kafer and G. E. Weed (Morgan Iron Works), Frank King (Maryland Steel Co.), F. E. Kirby (Detroit Dry Dock Co.), Lewis Nixon (Wm. Cramp & Sons), C. B. Orcutt (Newport News), J. F. Pankhurst (Globe Iron Works) and F. W. Wheeler (F. W. Wheeler Shipyard Co.). The remaining members are Messrs. W. H. Jaques, of the Bethlehem Iron Co.; J. W. Miller, of the Providence & Stonington Steamship Co.; Col. E. A. Stevens, President Hoboken ferries; Stevenson Taylor, of A. & W. H. Fletcher; Horace See, consulting engineer; Harrington Putnam, counsellor at law, and E. Platt Stratton, Chief Engineer, "Record of American and Foreign Shipping."

The first paper read was by Mr. Chas. H. Cramp, entitled "Evolution of the Atlantic Greyhound." The paper was an interesting retrospect of the progress made from the Inman steamer "City of Brussels," which, in 1869, broke the record with a passage of 7 d. 22 h. 3 min., to the latest achievement of the great Cunarders, "Campania" and "Lucania." The author then attacked the English practice of designing ships without initial stability, and keeping them upright by great quantities of water ballast or other dead weight. The English adhere to this with the avowed object of obtaining "an easy roll," but Mr. Cramp contended that safety demanded that a vessel should stand up at all times and in all conditions, without regard to whether her ballast tanks are filled or empty.

Concerning the size of vessels, he believed that with the "Campania" and "Lucania" the limit of commercial practicability had been met. In propelling vessels also, he considered that more than 12,000 I. HP. could not be economically transmitted through a single screw; hence, if a ship is to have more than 12,000 I. HP., twin screws are a logical necessity, and if 24,000 I. HP. is exceeded, triple screws must be used.

The two 536 ft. vessels which are being built by the Cramps for the International Navigation Co. will be launched next spring, and are to go into commission about a year from now. Their principal dimensions are:

Length (L. W. L.), 536 ft.; do. over all........ 554 ft.
Extreme breadth, 63 ft.; molded depth....... 42 ft.
Gross register, about....................11,000 tons.

Passenger capacity, 1st cabin, 320; 2d, 200; 3d, 900.

The vessels will have twin screws actuated by two quadruple-expansion engines on four cranks, which with steam at 200 lbs. pressure, are expected to develop about 20,000 I. HP. It will be seen that these ships are about half-way between the "Paris" and the "Campania" in size and power. These vessels are to be closely followed by other ships, which will not shrink from any comparison or competition.

Mr. J. A. Woodward, Asst. Naval Constructor U. S. N., then presented a paper on the "Determination of the Dimensions of a Vessel to Fulfill a Given Program of Requirements." The paper was a mathematical one, devoted to the discussion of some of the methods and formulas in use by naval constructors for this work. In the course of the paper the author pointed out the manner in which designers in the United States are hampered by the lack of an experimental tank where tests of various models may be made.

The U. S. Steamboat Inspection Service.

The next paper, by Mr. Jas. T. Boyd, General Manager Geo. D. Blake Mfg Co., gave rise to the most active discussion of the meeting. It was on the U. S. Treasury rules for the inspection of machinery and boilers. Mr. Boyd favored the revision of these rules in accordance with Senate bill No. 1.755. except that he would strike out the clause requiring a chief engineer of machinery above 2,000 I. HP. to be at least 30 years of age and to have served at least five years as first assistant engineer. Another unfortunate clause was that which made the law applicable to boilers now in service, which would have had the effect of reducing by 10% or more the working pressure of most of the boilers in use. He considered that the revision of the present laws and rules governing marine inspection should be intrusted to engineers of prominence, one from the Navy, one from the Revenue Marine and one from the Merchant Marine, and one captain from the Merchant Marine. As an instance of the inapplicability of the existing rules to present conditions, Mr. Boyd read a copy of a letter from Mr. J. F. Pankhurst, General Manager of the Globe Iron Works, of Cleveland, O., to the Board of Supervising Inspectors, with reference to the Safety-valves on the new Belleville boilers which the Globe Works are building for the Great Northern twin screw passenger steamers. The existing U. S. rules for calculating the size of safety valves was adopted in the days when 30 lbs. was considered a high pressure for a marine boiler, and it takes no account of the steam pressure in the boiler. The absurdity of this rule is shown by the fact that if the safety valves on these Belleville boilers were made the full size called for, they would have an area 2½ times as great as the cross-section of the main steam pipe, and would empty the whole boiler in 17 seconds at 250 lbs. pressure. The sudden opening of so large an exit at high pressure is generally conceded to be exceedingly dangerous and quite likely in itself to cause the explosion of a weak boiler.

The discussion on the paper showed entire unanimity on one point, that reform in rules, laws and methods of the inspection service was needed; but there were widely diverse opinions as to the principles which should govern in making reforms. It was pointed out that since public agitation on the subject had become so extended, the bureau of inspection was suddenly finding itself able to inaugurate changes which had long been denied. The ridiculous form of test piece, which has been so long upheld as a statutory necessity, has been discovered to be only a rule after all, and open to change without the action of that inactive body, the U. S. Congress.

A circular has been sent out during the present month establishing a new form of test piece, more in accordance with modern ideas.

Naval Constructor Bowles said that the steamboat inspection service did not command the respect, either of technical men or designers or of the men who run steamships. In any reform, however, it should be borne in mind that there are many objections to enacting technical rules into law. The fact that the Treasury Department is to-day inspecting material under a law passed in 1871 is sufficient proof of this. Such rules as are made to govern inspection should be made by a permanent board composed partly of government employes and partly of members from civil life, and such a board should have power to annul its rules.

Col. E. A. Stevens said that the grand trouble with the U. S. inspection laws is that there is no adequate representation of the Merchant Marine at Washington. The commerce of the country has reached a stage where it demands an officer of the rank of a cabinet officer to represent its interests at Washington. As an example of the lack of laws to meet commercial necessities, only a few years ago there were no anchorage rules in New York harbor, and a lumber schooner could anchor directly in front of a ferry-slip or of one of the trans-Atlantic steamer docks, and the only means of getting her out of the way was to go out and humbly offer to dock her free. Mr. E. P. Stratton heartily seconded Colonel Stevens and described the manner in which such bureaus as the Revenue Marine, the Lighthouse service, the Steamboat Inspection service, etc., had been piled on the Treasury Department.

Mr. McFarland, of Chief Melville's staff, made a personal explanation of the origin of Senate Bill 1,755 He was detailed to investigate and make a report on the matter in company with the chief of the Revenue Marine, and the report was made with the best information at their hands, but with no knowledge that it was to be enacted into law. The Treasury Department, however, divided the report into sections, and it was introduced as a bill by Senator Frye. It was not intended by the Senator to press the bill for passage until all parties having interests which were affected by the bill had had an opportunity to be heard, and it was merely put in the shape of a bill and printed to bring the question prominently before the public.

In general the further points brought out by the discussion were that Congressional legislation on the subject should be limited to cover general principles only, leaving details to the discretion of some permanently organized board or commission.

The next paper taken up, and the one of perhaps the greatest engineering interest of any paper read at the meeting was by Mr. R. W. Davenport, Second Vice-President Bethlehem Iron Co. We print it in full in another part of this issue.

Coal Bunkers and Coaling Ship.

This paper, by Lieut. A. P. Niblack, gave rise to an extended discussion. The author gave figures showing that with the present arrangement of bunkers and methods of coaling in use on naval vessels coaling is a most tedious process, and one which would seriously hamper the efficiency of a vessel in time of war. He advocated larger bunkers, and would even extend them across the vessel with a large movable trunk for delivering coal to them from the deck. He would fit all ships with side davits over each side coaling port, and would make these ports large enough to admit good-sized bags. The naval constructors and engineers who discussed this paper agreed that the indictment by the author of present methods of coaling and stowing coal was true; but contended that his proposed remedies were impracticable, as the space demanded was already taken up for other necessary purposes. Mr. Bowles said that to construct such a vessel as the "New York" in the manner Mr. Niblack proposed would add at least 20% to its cost. A fact of a good deal of interest which came out in the discussion was that on the "New York," in the sleeping quarters of the crew, on the berth deck, the temperature was at times as high as 110°.

The Banquet.

The social event of the meeting was the banquet, held at the Brunswick on Thursday evening. President Griscom presided, and ex-Secretary Tracy was seated on his right, and responded to the toast "Our Navy." He said that hardly 10 years ago not one man in a thousand would believe that a modern warship could be built in the United States. Now the nations of the world are satisfied that nowhere can better ships be produced than in the United States. The "New York," "Columbia" and "Olympia" are three vessels unequaled in any navy in the world. We have taught other nations how to make armor plate that will beat the gun. He believed that if a good navy were built, a good merchant marine would necessarily follow. Among the other speakers were J. R. Soley, late Assistant Secretary of the Navy; Gen. T. W. Hyde, of the Bath Iron Works; Col. E. A. Stevens, of the Hoboken ferries, and Commander J. W. Miller, of the New York Naval Reserve.

Friday's Sessions.

When the Society reassembled on the second day of the convention a paper by ex-Chief Constructor Theo. D. Wilson, on "Steel Ships of the U. S. Navy" was presented. Since 1883, said the author, 43 vessels and 2 torpedo boats have been added to the navy. The weak points of the navy, as at present constituted, are the lack of torpedo gunboats, torpedo boats and line-of-battle ships. Our policy of building cruisers larger, faster, and with heavier armament than any existing vessels has been adhered to in the vessels of most recent construction. It speaks highly for the resources of the United States in private shipyards, that all but four of the new vessels have been built by contract. Following this came Chief Engineer Melville's paper, "Notes on the Machinery of the New Naval Vessels." We shall reprint it in a following issue.

After an extended discussion on this paper the Merchant Marine had the floor, and Wm. W. Bates, late Commissioner of Navigation of the U. S. Treasury Dept., read an interesting paper, comparing the performance of the American and foreign freight vessels plying in the grain trade between San Francisco and European ports. The author had collected statistics extending over a period of several years, which showed that the average American wooden ship beat all other vessels in size, weight and value of cargo and cheapness and safety of carriage. The figures, however, referred to the period 1880-1885, and the question might be raised whether similar figures now would tell the same story.

Following this came a paper by Col. E. A. Stevens on the design of ferry-boats, which was discussed by Messrs. Du Bosque and Hayward, of the Motive Power Dept., Pennsylvania R. R., and also by Messrs. E. P. Stratton and F. Merriam Wheeler. Prof. W. F. Durand, of the School of Naval Architecture at Cornell, then read a discussion of the mathematical law governing frictional resistance. There was a brief discussion, and a paper was then read on the use of steam yachts as part of a Naval Reserve. The author advocated an arrangement by which steam yachts should be modified in design, so that they could be readily adapted for use as torpedo-boats, small cruisers or dispatch vessels in case of war, the government inducing owners to adopt such modifications by the payment of their cost and by attending to the inspection of the vessels during construction and service. The two final papers were: "The Influence of Speed and Weight of Machinery on the Determination of the Other Elements of Design of Steam Vessels," by Jas. J. O'Neill, and "The Wetted Surface of Ships," by D. W. Taylor, Naval Constructor, U. S. N. The complete papers and discussions of the meeting are to be published by the Society at an early date and can be obtained, after publication, of the secretary, Mr. Washington L. Capps, Washington, D. C.

COMING TECHNICAL MEETINGS.

DENVER SOCIETY OF CIVIL ENGINEERS.
Nov. 27. Secy., F. E. King, Jacobson Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Dec. 1. Secy., E. K. Smoot. 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Dec. 1. Secy., O. Von Geldern, 719 Market St., San Francisco.
ENGINEERS' CLUB OF PHILADELPHIA.
Dec. 2. Secy., L. F. Rondinella, 1122 Girard St.
SWEDISH ENGINEERS' CLUB.
Dec. 2. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 4 to 8. Secy., F. R. Hutton, New York.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Dec. 4. Secy., C. L. Annan. City Engineer's Office.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Dec. 5. Secy., W. Halliburton.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Dec. 6. Secy., F. Collingwood. 127 East 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
Dec. 6. Secy., Arthur Thacher. Odd Fellows' Building.
WESTERN SOCIETY OF ENGINEERS.
Dec. 6. Secy., Jno. W. Weston. 51 Lakeside Bldg., Chicago.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Dec. 7. Secy., C. H. McLeod. Montreal. P. Q.
ENGINEERS' CLUB OF MINNEAPOLIS.
Dec. 7. Secy., E. Nexsen. 504 Kasota Block.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Dec. 9. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
Dec. 11. Secy., Waterman Stone. Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
Dec. 11. Secy., M F. Schinke. City Hall.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Dec. 12. Secy., F. C. Osborn. Case Library Bldg.
NORTHWEST RAILROAD CLUB.
Dec. 12. Secy., W. D. Crosman. Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Dec. 12. Secy., D. W. McMorris. Burke Block. Seattle, Wash.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Dec. 13. Wichita. Kan.
NEW ENGLAND RAILROAD CLUB.
Dec. 13. Secy. F. M Curtis. P. O. Box 1576, Boston.
ENGINEERING ASSOCIATION OF THE SOUTH.
Dec. 14. Secy., W. G. Kirkpatrick, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Dec. 14. Secy., F. W. Mowbray, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Dec. 15. Secy., D. W. Meeker. St. Paul.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Dec. 15. 201 Washington Building.
COLUMBIAN ENGINEERING SOCIETY.
Dec. 19. Secy., F. W. Hart, Washington, D. C.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Dec. 19. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
Dec. 19. Secy., Clement F. Street, Chicago.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Dec. 20. Secy., L. J. Carmalt, Roanoke, Va.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Dec. 20. Secy., S. E. Tinkham. 36 Broomfield St.
ENGINEERS' CLUB OF CINCINNATI.
Dec. 21. Secy., J. F. Wilson, 24 W. 4th St.
NEW YORK RAILROAD CLUB.
Dec. 21. Annual meeting. Secy., John A. Hill, Temple Court.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Dec. 21. Secy., Allen Strale, 100 Washington St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 18. Secy., S. A. Charpiot, Macon, Ga.
CENTRAL RAILWAY CLUB.
Jan. 24. Secy., S. W. Spear, Buffalo, N. Y.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.
Entered at the Post Office, New York City,
as Second Class Matter.

VOL. XXX. THURSDAY, NOV. 23, 1893.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
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SAMPSON LOW, MARSTON & CO (Limited), St. Dunstan's House, Fetter Lane, London, Eng.

SUBSCRIPTION RATES: One year, $5.00; 6 months, $2.50 ; 4 months, $2.00 ; single copies 15 cents. To all foreign countries in the Postal Union, add $2.08 to above prices for postage. Subscribers can have the mailing address of their paper changed as often as they desire. They should send both the old and the new addresses. No club rates are allowed.

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The members of the Society of Naval Architects and Marine Engineers are to be congratulated on the success of their first regular meeting, held last week in New York city. It is true, those who attended the sessions of Division G, of the International Engineering Congress last August, which were under the charge of this Society, were led to expect something very good when the Society met as an entirely independent organization. It is risking nothing to say that, judging by that best index, the character of the discussions, the work done in Section G was equal to that done in any of the other sections, conducted by the oldest and largest national engineering societies. It remained to be seen how far the promise held out by that first meeting would be sustained when the Society met with only its own membership to rely upon for papers and attendance. The sessions held last week, however, were as highly creditable to the Society as were those held at Chicago. The papers were of a high order of excellence; the discussions were brisk and were participated in by members who did not talk merely for talk's sake; the interest in the proceedings by those in attendance, which is the best criterion of success in a technical society's meetings, was maintained throughout all the sessions in a highly creditable manner. The Society has certainly demonstrated already that the belief of its founders, that the subjects to be brought before it constituted so distinct a department of engineering as to justify the existence of a separate society devoted to its advancement, was entirely correct.

In some respects the Society will gain wisdom as it grows in experience; and it might profitably take a hint from the experience of other societies in one point especially, the presentation of papers by abstract only instead of in full. The reading in full, when papers are printed and distributed to the members in advance of the meeting, consumes time which might much better be devoted to discussion, especially when members show such interest and willingness to carry on discussion as was the case in the meeting held last week.

◆

Of the papers read at the meeting, the one of, perhaps, the most general interest to engineers is that which we reprint in this issue, describing the great steel forging plant which has been installed by the Bethlehem Iron Co., and the work turned out and methods in use there. It is probably not as generally realized as it should be that it is the enterprise of the Bethlehem Iron Co. that has made the United States no longer dependent on foreign manufacturers for the largest and most expensive class of steel forgings, which are necessary in the construction of modern marine engines.

The concluding portion of the paper, in which the author describes the latest advancements in the manufacture and use of nickel-steel, is of direct interest to all branches of the profession. More or less has been said concerning the use of nickel-steel for other purposes than ordnance; but Mr. Davenport's paper points out more clearly than we remember to have been done before just what can be accomplished with this new metal. The virtues of nickel in steel can be briefly summed up by saying that it enables the percentage of carbon to be increased with consequent increase in the elastic limit and ultimate strength, but without material decrease in the ductility. To put it in practical terms, nickel-steel forgings are now commercially available which have an elastic limit as high as the ultimate tensile strength of the soft steel ordinarily used for forgings, and yet are so tough that a piece 2½ ins. square has been bent double cold without cracking. The modern tendency in engineering is to proportion members to strains by the elastic limit of the metal, instead of its ultimate strength. The elastic limit of large forgings of wrought iron is said to be little, if any, above 20,000 lbs. per sq. in. The soft steel commonly used for forgings has an elastic limit in the finished piece of about 30,000 lbs.; but nickel-steel of best quality under proper treatment reaches an elastic limit of 50,000 to 65,000 lbs.

Certainly such an improvement in metallurgy is one which should find a thousand and one applications. Wherever limitations in size and the demand for abundant strength are in conflict, nickel-steel should prove a great boon to the engineer. The amount of nickel used in treating steel is about 3%, which at present market prices of nickel (about 50 cts. per lb.) should ultimately increase the cost of steel only about 1½ cts. per lb. To offset this, there is the reduction in the weight of the steel used on account of the smaller size which may be used. Provided the demand for nickel does not prove so much in advance of the supply as to send the price skyward, there seems every reason to expect that nickel-steel is to be one of the most important materials at the command of the engineer.

◆

On Monday last, Judge Townsend, of the U. S. Circuit Court, filed a decision in the suits of the Westinghouse Air-Brake Co. against the New York Air-Brake Co., for infringement of its patents for the quick-action air-brake system. There were three separate suits, all of which were argued in January last, and, on account of the importance of the air-brake question to the railways at the present time, a decision has been looked for with great interest and some impatience. Judge Townsend has apparently taken great pains with his decision, to avoid the danger of reversal on appeal.

In the first suit the action was based upon an alleged infringement in the construction of the first quick-action triple valve of the New York company, of patent No. 393,784, issued to Harvey S. Park, and now controlled by the Westinghouse Air-Brake Co., and for an alleged infringement of patent No. 222,803, for an engineer's valve, issued to George Westinghouse, Jr., in the construction of the New York company's engineer's brake valve.

In the second suit it was claimed that both the first and the second triple valve constructions of the New York Air-Brake Co. infringed claim 3 of patent No. 172,064, for triple valve construction, issued to George Westinghouse, Jr., and claims 1, 2, 3 and 6 of patent for quick-action triple valve No. 376,837, issued to George Westinghouse, Jr.

In the third suit both forms of the quick-action triple valve of the New York company are claimed to infringe the quick-acting valve mechanism of patent No. 448,827, issued to George Westinghouse, Jr.

Judge Townsend decides these cases as follows:

In the first suit the bill is dismissed as to the infringement of the Park patent, while a decree for an injunction and an accounting is entered as to the New York company's engineer's brake valve.

In the second suit the bill is dismissed as to infringement of claim 3 of patent No. 172,064, and claim 6 of patent No. 376,837, both of which are for comparatively unimportant details of construction. The first has been abandoned by the New York company in their recent construction, apparently because of mechanical defects, while the second (claim 6) appears to have been thrown out only as referring to a non-patentable mechanical detail. The more important part of this decision is that a decree is entered for an injunction and accounting as to claims 1, 2 and 3 (the broad foundation claims) of the quick-action triple valve patent No. 376,837.

In the third suit also an injunction and accounting is ordered.

The decision, in brief, is that the New York company's engineer's brake valve and each form of their quick-action triple valve are infringements, and that company is enjoined from manufacturing the same, and an accounting for damages ordered in each case.

◆

The scope of this decision is a very broad one, in that it establishes the broad claims of patent No. 376,837, which is for that form of the quick-action triple valve adopted by the Westinghouse Air-Brake Co. for its standard and in general service. In addition, also, it establishes the subsequent patent No. 448,827, which covers broadly that form of triple valve construction in which the opening of the emergency valve is independent of the action of the triple valve proper and depends solely upon the rate of reduction of the train-pipe air pressure in applying the brakes.

While each of the styles of construction of the New York company's quick-action triple valve device is a more apparent and direct infringement of the latter patent, the decision that they each also infringe the patent upon which the second suit was based gives a broad scope to that patent, and unless the decision should be appealed from and reversed, it appears to establish clear legal title of the Westinghouse company to the quick-action air-brake system, as we have many times said is their right, in equity, as its admitted and sole originators.

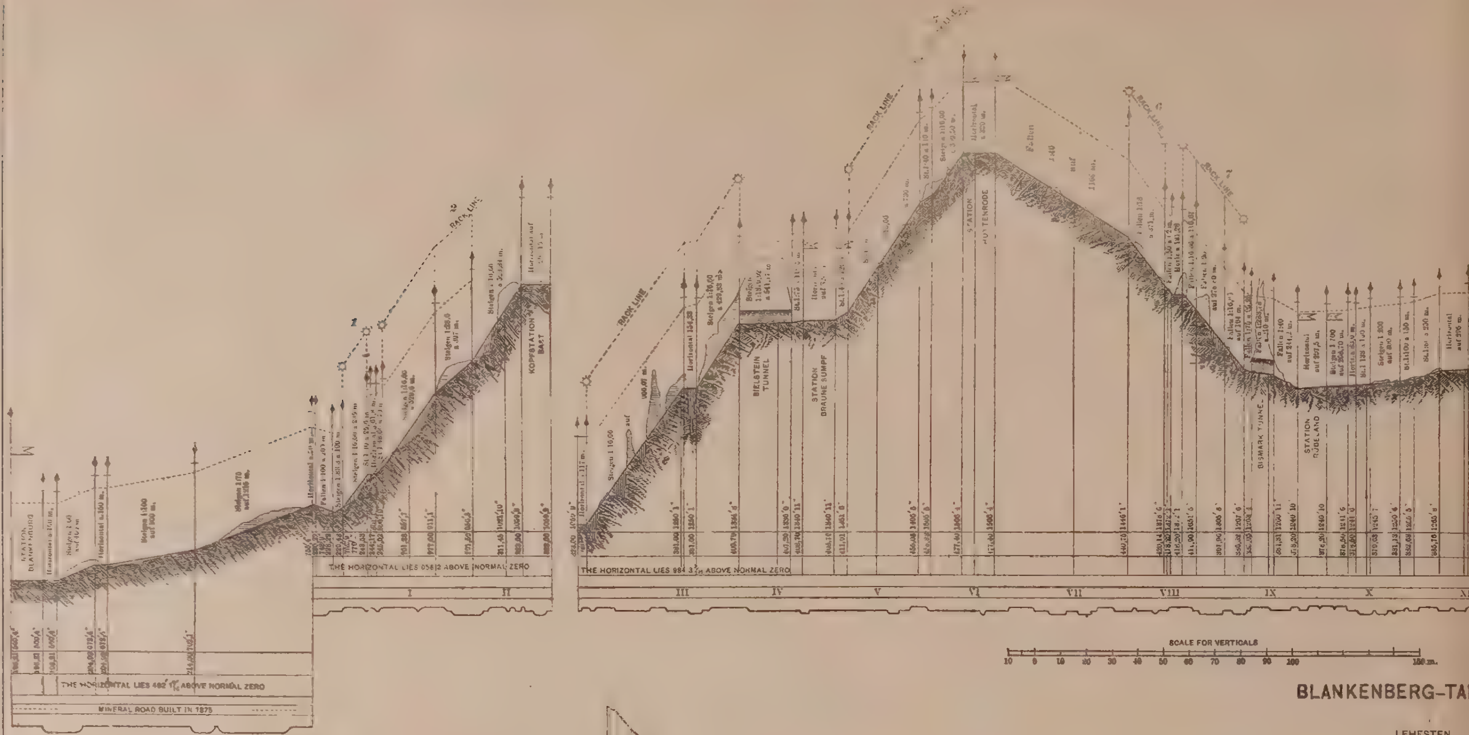
The opinion accompanying the decision is a very long one, and, as we have been unable to review it, we are not prepared to comment upon it at the present time; but, from the far-reaching nature of the decision itself, in establishing the validity of the broad claims of the Westinghouse patents, it would appear to be impossible to construct a quick-action air-brake mechanism, which would not fall within the lines of infringement upon the rights of that company.

◆

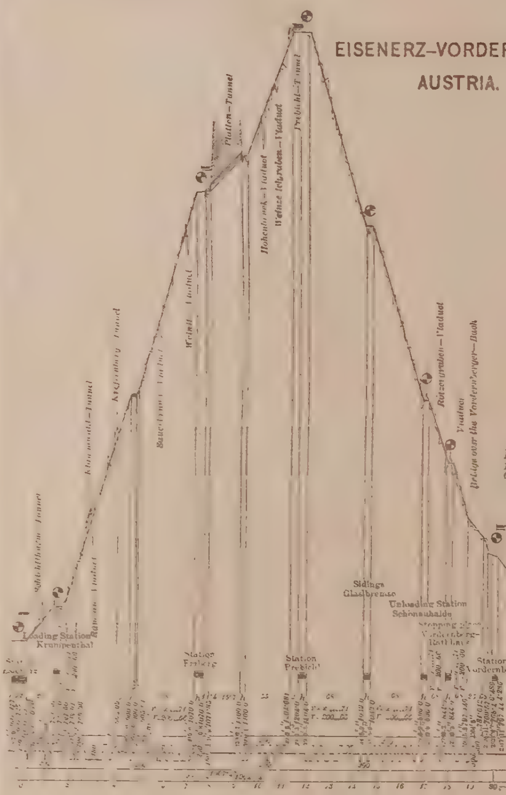
The whole difficulty seems to have arisen from a defect of form in Mr. Westinghouse's first patent. What he had in fact invented was a new principle or process of brake application by which the trainpipe was emptied of air by release at each triple valve as soon as the impulse reached it, instead of being emptied from one end only, which necessarily took a much longer time and thus produced the frightful shocks which threatened to forbid and would have much delayed the extension of the air-brake system to freight service.

This was a wholly new conception and was a contribution to the arts of the first importance, quite independent of the particular mechanism which might be used to carry out the process; but by a serious oversight what Mr. Westinghouse's first patent really covered was little, if any, more than a particular mechanism for carrying out this process. Fortunately for him and for abstract justice, he discovered the possibility of using other mechanisms for the same end before any one else did, and covered them also by claims of greater breadth than in the first patent.

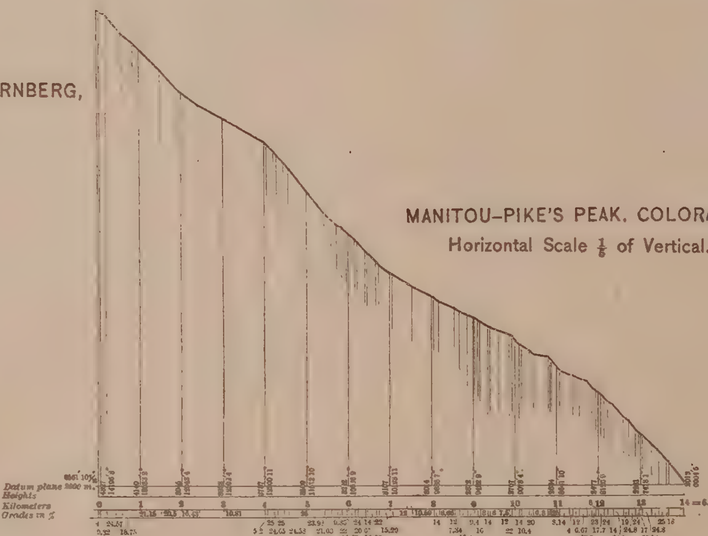
It is admitted on all hands, we believe, that Mr. Westinghouse was the original and first inventor of this process and was entitled to cover it broadly in his first patent; but the subsequent litigation has hung on the technical point that, having failed to do so in his first patents, he was not entitled to do so any more broadly in his later patents, under the general rule of the patent law that what a man discloses but does not claim in a patent neither he nor any one can patent later. In his


BACK LINE
KOPFSTATION BAST
BIELSTEIN TUNNEL
STATION BRAUNE SUMPF
STATION HÜTTENRODE
BISMARK TUNNEL
STATION RÜBELAND
THE HORIZONTAL LIES 482 1/2 ABOVE NORMAL ZERO
MINERAL ROAD BUILT IN 1873
THE HORIZONTAL LIES 658 ABOVE NORMAL ZERO
THE HORIZONTAL LIES 884 3/4 m ABOVE NORMAL ZERO
I
II
III
IV
V
VI
VII
VIII
IX
X
SCALE FOR VERTICALS
10 0 10 20 30 40 50 60 70 80 90 100 150 m.

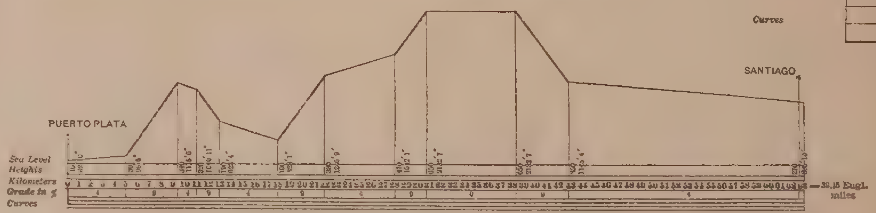
BLANKENBERG–TA



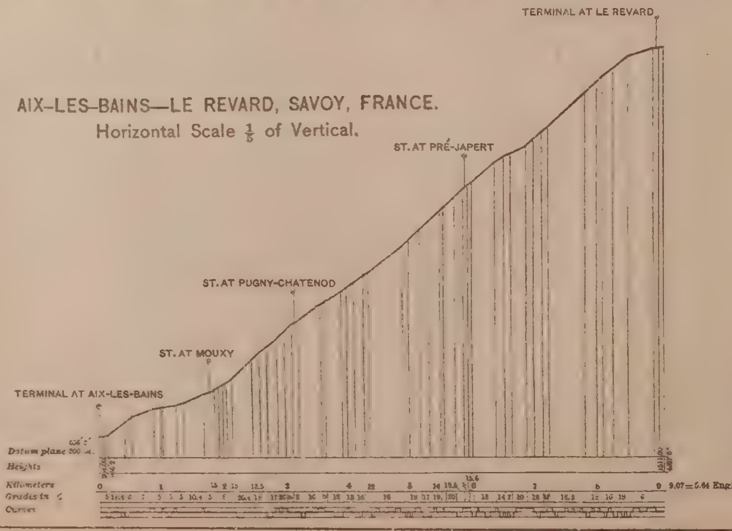
EISENERZ–VORDERNBERG, AUSTRIA.



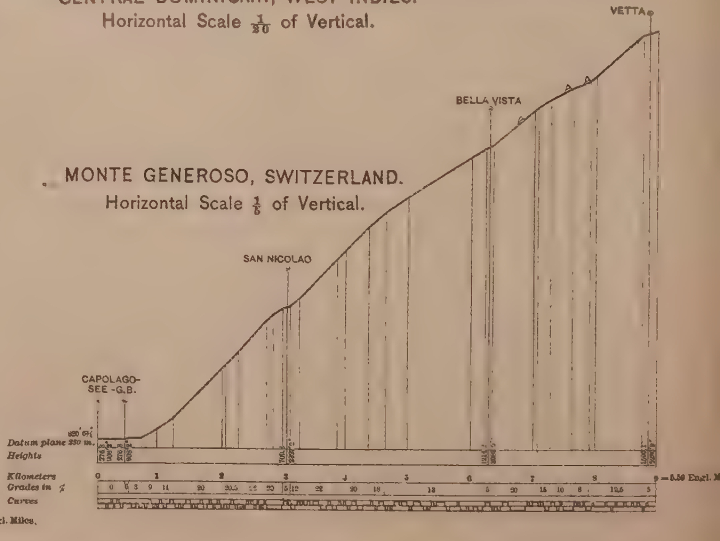
MANITOU–PIKE'S PEAK, COLORADO.
Horizontal Scale $\frac{1}{5}$ of Vertical.



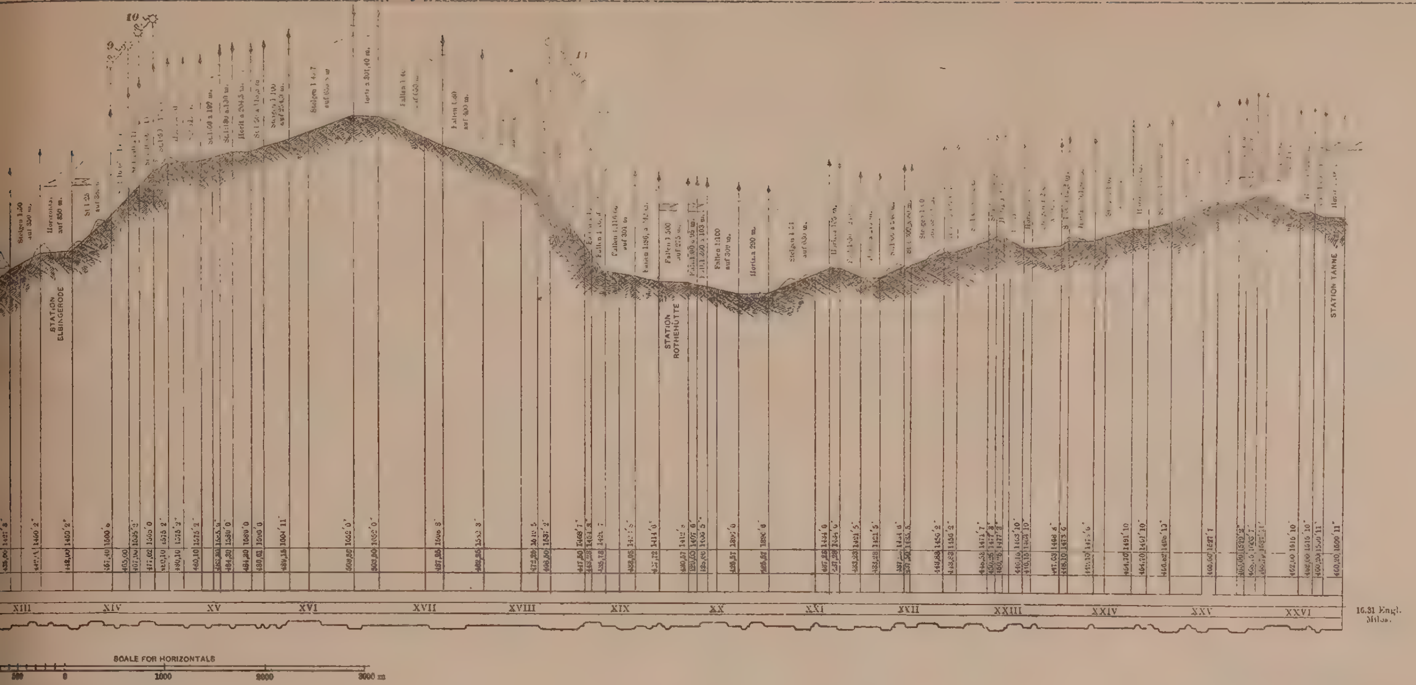
CENTRAL DOMINICAIN, WEST INDIES.
Horizontal Scale $\frac{1}{30}$ of Vertical.



AIX-LES-BAINS—LE REVARD, SAVOY, FRANCE.
Horizontal Scale $\frac{1}{5}$ of Vertical.

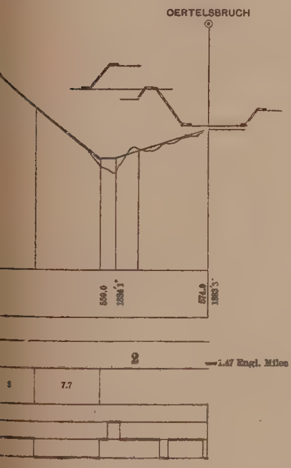


MONTE GENEROSO, SWITZERLAND.
Horizontal Scale $\frac{1}{5}$ of Vertical.

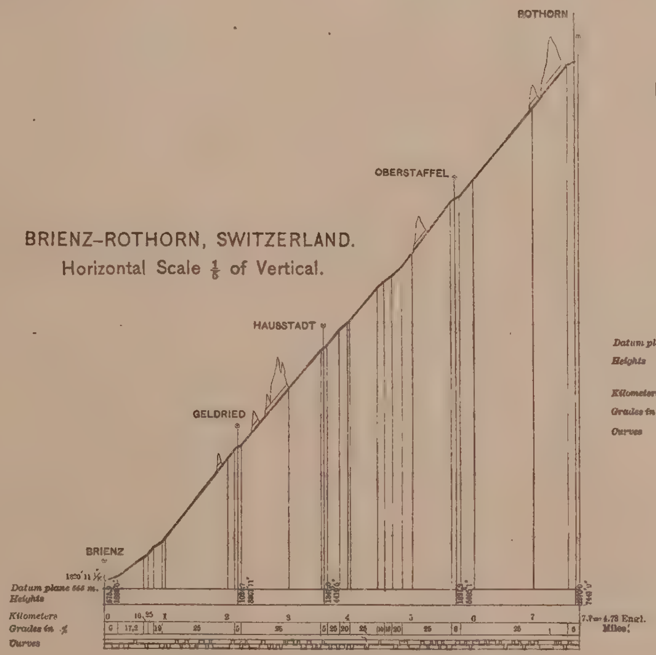


, GERMANY.

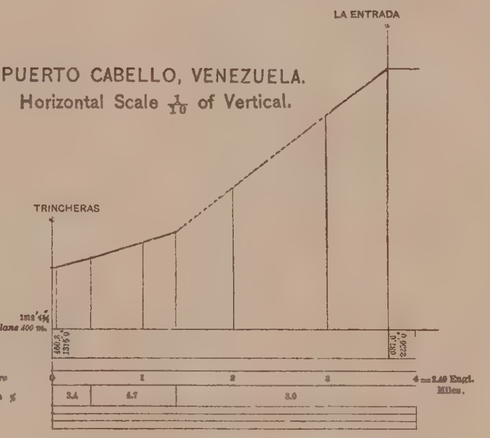
THUERINGIA, GERMANY.
cale $\frac{1}{10}$ of Vertical.



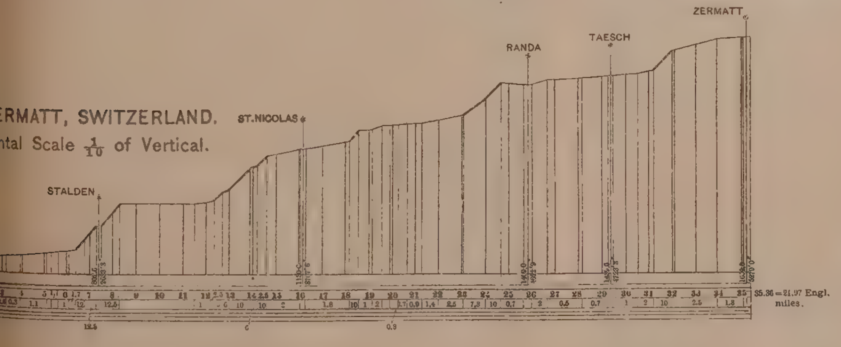
BRIENZ-ROTHORN, SWITZERLAND.
Horizontal Scale $\frac{1}{5}$ of Vertical.



PUERTO CABELLO, VENEZUELA.
Horizontal Scale $\frac{1}{10}$ of Vertical.



ERMATT, SWITZERLAND.
ntal Scale $\frac{1}{10}$ of Vertical.



GLION-NAYE, SWITZERLAND.
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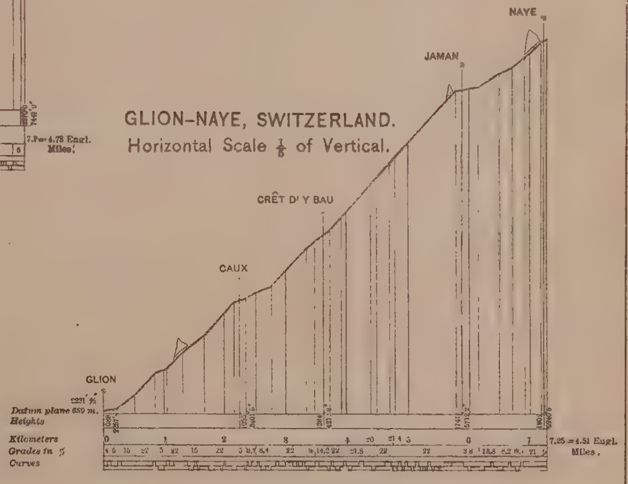
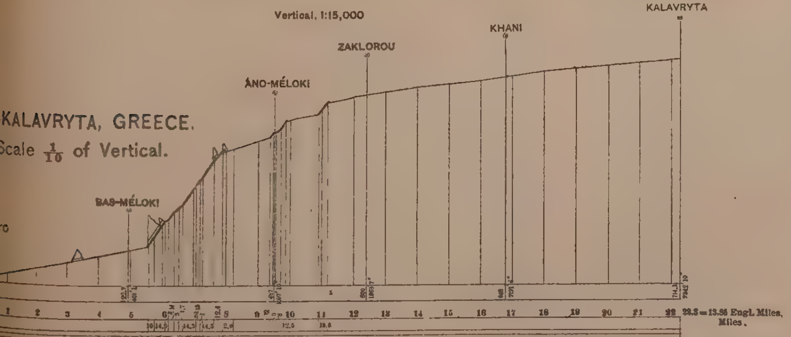


KALAVRYTA, GREECE.
Scale $\frac{1}{10}$ of Vertical.



PROFILES
OF THE MOST NOTABLE
MOUNTAIN RAILWAYS
CONSTRUCTED ON
THE ABT RACK SYSTEM.

CHAS. HART & SONS, LITH., 86 VESEY ST., N. Y.

first application, Mr. Westinghouse unquestionably disclosed a novel and highly important process which he did not claim, and as we understand it, his hold upon the process now depends only on the chance fact that there are only three possible mechanical devices for carrying out the process, and that he covered each of these by as many different patents before any one else applied for any. Had there chanced to be an indefinite number of such mechanical devices possible, as might often be the case, his case in equity would have been equally strong, but his legal rights might easily have been wholly lost under otherwise similar conditions.

CONCERNING USEFUL ENGINEERING ACQUAINTANCES.

One of our correspondents, a young man who has received an engineering education and is now beginning the actual practice of his profession, asks us the following question: "How can I best extend my acquaintance among older engineers, so that I may advance my own professional interests by attracting their attention and thus gain better employment when the opportunity offers?"

This is a pertinent question for which nearly every young engineer has at some time sought a solution; and it is a question susceptible of an unusually satisfactory answer. The surest, even if the slowest, method is the faithful performance of duty, strict attention to the detail of work intrusted to the assistant and an earnest desire to do everything promptly and well, no matter how trivial it may seem. To make yourself generally and intelligently useful to your superiors is the readiest method of securing their support and encouragement, and opens the door to a useful acquaintance with their engineering friends. Agreeable manners, a quickness of perception, so that orders may be promptly and intelligently executed, and a respectful but not servile attitude toward all in authority are important elements in advancing the beginner in the career he has chosen.

There is one other and an excellent way of introducing a young man's name to the engineering profession, and that is by contributing to technical literature. One of the editors of this journal can gratefully trace much of later substantial success to the advice of an old and well known engineer to describe carefully and fully for publication the details of a somewhat novel piece of engineering work, with the execution of which chance had intrusted him. He was then at the beginning of his career; his acquaintance among engineers was very limited; and of engineering societies or their publications he knew scarcely anything. He had never written for the printer and timidly doubted his ability to write anything; and when he did begin he made the too common mistake of omitting mention of really important but seemingly petty details and paid most attention to the selection of words and the rounding of sentences. But under the friendly criticism and advice of the older engineer he finally told the whole story, concisely, but with every detail of weights, cost, method and time of execution and with frank avowal of all failures as well as the recital of successes. This one article, published in a scientific journal, made the young man a member of the American Society of Civil Engineers, and introduced him to the older Institution of Civil Engineers by the republication of his paper in their transactions. In fact, the preparation of this single paper gave him a wider acquaintance among the men he wanted to know than years of a quiet pursuit of his profession would have done.

Almost any young engineer can do the same, for the cases are rare in engineering work where something novel in practice does not turn up. It may be only a new device for doing some special class of work; some noteworthy case of preservation of iron or timber, or a failure due to some seemingly unimportant cause. But the young engineer who uses the powers of observation given him, carefully notes and records conditions and surrounding influences, and is above all careful and trustworthy in making his observations and deductions, will usually some time find something worth telling to other engineers. He does not need experience in writing for publication, and need not be a master of sentences. The plainer he speaks, the more concisely he tells his story, so that it be understood, the more likely it is to attract the attention of busy and prominent members of the engineering profession. A letter to a technical journal may convey all he has to say on a certain subject; and he can depend upon the editors to cut it up into proper paragraphs and to put it generally into shape. And the same journals are always ready to publish concise, clear and longer descriptions of the details of public or private works, especially if these descriptions are well illustrated by drawings and photographs.

Still another and important method of extending acquaintances in engineering circles is for the young man to identify himself as soon as possible with some national as well as local engineering society. He will thus, at longer or shorter intervals, according to his location, meet other engineers and at all times have the benefit of their publications. But even then, if he would attract the attention of the older engineers, he must write or speak upon technical subjects whenever he has something to say worth saying.

The secret of success in the line of useful and interesting contributions to discussions or technical literature is the art of taking copious and careful notes of engineering facts and details at the time these present themselves. This notebook making is unhappily almost a lost art among the younger generation of engineers, for the abundance of engineering periodicals and textbooks upon almost all subjects tends to make them careless of personal notes; the idea being that they can at any time and at all times turn to their books for the special information wanted. This is a mistake, and especially a mistake for the young man. With the earlier engineers the almost total absence of technical literature compelled them to gather information where and when they could, and to the resulting notebooks the present generation is more indebted than it seems to know. From the notes made during a busy lifetime the late John C. Trautwine evolved his now invaluable "Pocket-book," and many another valued engineering work has had a similar basis. At the present time notemaking is a matter of policy and education rather than one of necessity; but a little reflection will demonstrate that it is quite as useful now as then. Notes made upon the spot do, or should, record facts and details that are not generally found in books, even when books are accessible. If they apply to methods and cost of construction, time and conditions of execution, they impress themselves upon the memory of the young engineer and train him in a way nothing else will. And this training is all the more beneficial now because he has books which often present a basis for comparison of results and the correction of errors of judgment. Notes are a record of the experience of others as well as of personal experience, and the fuller they are and the wider the field covered, the broader is the education of the engineer in the best school of all—that of experience. The young man who conscientiously follows this advice will sooner or later have something to write or to say worth reading or listening to; and useful engineering acquaintances and professional advance are very likely to follow.

LETTERS TO THE EDITOR.

THE ECCENTRIC LOADING OF CAST IRON COLUMNS.

Sir: The very timely remarks of Mr. F. von Emperger, in Engineering News of Nov. 9, respecting the eccentric loading of cast iron columns, bring to mind a matter discussed, within a year or so, at our engineers' club here, a matter which, I believe, is less generally known than it should be. I refer to the fact that owing to eccentricity of the resultant of pressures or tensions in a larger section, such section may be weaker than a smaller one through which the same resultant passes symmetrically, or more nearly so. In fact, it is possible to weaken a piece subjected to stress by merely adding to its cross-section (and that without reference to the weight of the added material) if the addition is so made as to render the resultant eccentric to the cross-section.

It is well known that in a given rectangular cross-section, such as a masonry joint under pressure, the stress will be distributed uniformly over the section only when the resultant passes through the center of the section; that any deviation from such a central position will bring a maximum unit pressure to one edge and a minimum to the other; that when the distance of the resultant from one edge is one-third of the entire width of the joint, the pressure at the nearer edge is twice the mean pressure, while that at the farther edge is zero, and that when the resultant approaches still nearer to the edge the pressure at the farther edge becomes less than zero; in fact, becomes a tension, if the material (mortar, etc.) there is capable of resisting tension. Or, if, as usual in masonry joints, the material is practically incapable of resisting tension, the pressure at the nearer edge, when the resultant approaches it nearer than one-third of the width, increases very rapidly and dangerously, becoming theoretically infinite when the resultant reaches the edge.

But it is, I believe. not so commonly known, or, at any rate, it is not so commonly borne in mind, that with a given position of the resultant relatively to one edge of the joint or section, a similar redistribution of the pressures throughout the section may be brought about by simply adding to or diminishing the width of the section.

Let Fig. 1 represent a side view of a bar of uniform thickness = 1, but (as shown) of varying width, and subjected to pressures, the resultant P of which is = 1, and passes through the center of that section, a b, whose width is = 1. (I adopt these unit values simply for convenience.) The pressure per unit of area of cross-section (or unit stress) in the section a b is then $\frac{P}{a\,b} = \frac{1}{1} = 1$, and (assuming perfect rigidity and perfect contact of the surfaces) is uniformly distributed over it. But at other sections of the bar the unit stress is a maximum at the edge nearest to the resultant, and diminishes gradually and uniformly to a minimum at the farthest edge. This is indicated by the shaded triangles and trapezoids in Fig. 1 and by the curves in Fig. 2, which show, for the several sections in Fig. 1, the mean unit stress, and the unit stresses at the upper and lower edges, respectively, calculated by the following well known rules:

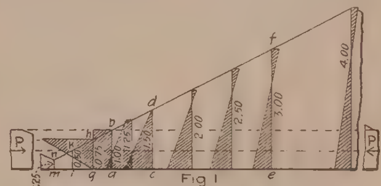


Fig 1

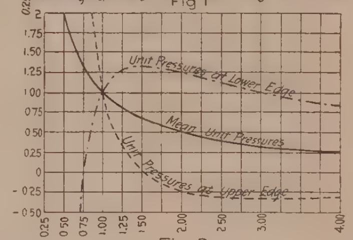


Fig. 2

Let P = the total pressure on any section.

w = the width of that section = the area of the section, since thickness = 1.

$p = \frac{P}{w}$ = the mean unit pressure on the section.

M = the maximum unit pressure on the section.

m = the minimum unit pressure on the section.

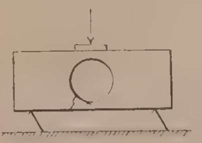


Fig.3

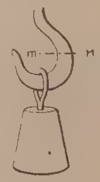


Fig.4

d = the eccentricity of the resultant = its distance from the center of the section.

Then $M = p\left(1 + \frac{6\,d}{w}\right)$ and $m = p\left(1 - \frac{6\,d}{w}\right)$.

These stresses are given also in the following table:

Unit Stresses in Fig. 1: the Unit Stress $\frac{P}{a\,b}$ in Section a b Being taken as 1.

Section.	Width.	Stress per unit of area of cross-section. Mean.	At low edge, m e.	At up. edge, h f.
	4.00	0.25	0.8125	—0.3125
e f	3.00	⅓	1.00	— ⅓
	2.50	0.40	1.12	—0.32
	2.00	0.50	1.25	—0.25
c d	1.50	⅔	1⅓	0
	1.25	0.80	1.28	0.32
a b	1.00	1.00	1.00	1.00
g h	0.75	1⅓	0	2⅔
i k	0.50	2.00	—4.00	8.00
m n	0.25	4.00	—32.00	40.00

It will be noticed that among the sections narrower than 3 a b, the strongest is that, a b, which the resultant cuts symmetrically; and that among the sections wider than a b the weakest is that (c d) whose width is = 1.5 a b. At that section the lower edge, m e, has its maximum unit stress (= 1⅓ p), while at d, in the upper edge, there is no pressure. Beyond c d the upper edge, n f, is in tension, and the unit pressure along m e decreases, becoming again = p at e f, where the width, e f, is = 3 a b, and decreasing still further with further increase in the width. In other words, a bar of the shape a b e f (cutting off for the present the narrower portions to the left of a b), subjected to a uniform pressure or tension applied uniformly over the surface a and over an equal area, as indicated at P on the right, ought to begin to fail by crippling of the fibers or particles at c in that section, c d, where the width is = 1.5 a b.

A curious fact, very neatly illustrating this principle, was mentioned by Mr. Wilfred Lewis at the last meeting of the club.

In testing some cast iron beams provided with central circular openings, it was found that they uniformly failed, not at the smallest section immediately under the opening, as might have been, and was expected, but at a point a little way round from this, as indicated in Fig. 3.

In this case the resultant of the tensions no doubt passed pretty near the middle of the smallest section, and was eccentric to the fractured section.

Referring again to Figs. E and F, and observing the narrow sections to the left of a b, it will be noticed that the upper edge of the bar, inasmuch as it is now nearest to the resultant, receives the maximum unit pressure; that when the width is = ¾ a b, as at g h, the distance of the resultant from the upper edge is ⅓ the width of the section, the pressure at the lower edge is = 0, the mean pressure in g h is = 1⅓ p, and the pressure at the upper edge is twice this, or 2⅔ p; and that when the width becomes less than ¾ a b, as at i k and m n, the pressure at the lower edge, m e, becomes negative or tensile. As the section is further reduced, the stresses are still further and very rapidly increased. The condition of these sections (such as m n) where the resultant passes outside of the section, is similar to that of the section m n of a bent hook sustaining a load, as in Fig. 4.

John C. Trautwine, Jr., Assoc. Am. Soc. C. E.
Philadelphia, Nov. 11, 1893.

THE DAILY PRESS ON RAILWAY ACCIDENTS.

Sir: Inclosed I send you a solid column of newspaper opinions on the causes of railway accidents that may be of interest to you as showing the entire ignorance of various editors regarding the existence even of mechanical safeguards not now in use.

It is sent after reading your editorial comments on editors and railway accidents last week. It is cut from the Chicago "Herald" of Oct. 28. and gives comments of 19 different newspapers on the causes of the recent excess of accidents, the general nature of all of which is to the same purport as this quotation from the first one, viz.: "The guilt of the managers has been in many cases great and obvious. They have overworked their employees. This is the plain truth, and it needs to be reiterated." Beyond one or two casual allusions not a word is said nor a hint given in relation to any omission to use recognized mechanical appliances to insure safety.

Yours truly, Frank P. Kellogg.
Havana, Ill., Oct. 30, 1893.

(Our correspondent correctly describes these extracts, which include opinions from the New York "Tribune," "Times," "Evening Post," "Sun," "Herald" and "World"; Philadelphia "Times"; Boston "Herald"; Detroit "Journal," "Free Press" and "Tribune"; Toledo "Bee"; Toronto "Mail"; Indianapolis "Journal," "Sentinel" and "News," and sundry other Chicago, Milwaukee, Minneapolis, St. Paul and Kansas City journals.

In the course of time the editors of these and other well meaning sheets may come to realize that the dog who persistently barks up the wrong tree may be filled with good intentions, but he does not help on the hunt much.—Ed.)

FLAT CAR OF FOX PRESSED STEEL CO.

Sir: In your issue of Oct. 12, p. 299, there is mentioned a flat car exhibited by the Fox Solid Pressed Steel Co. at the World's Columbian Exposition. This car you described correctly as 30 ft. long, 26,200 lbs. weight, and "rated" carrying capacity of 100,000 lbs. An attendant at this exhibit, when questioned, stated that the journals were "5½ ins. diameter and 8½ ins. long."

I measured the diameter of the outside of collar, which was the only thing accessible, and found it to be only 5¼ ins., which is just the outside diameter of the M. C. B. standard 4¼-in. journal. Therefore, it is fair to assume that this car is carried on M. C. B. standard journals. It has two four-wheel trucks; the truck load is 63,100 lbs., and the journal load is 15,775 lbs. What warrants the designer of this car in increasing the journal load 25% over the M. C. B. standard? Very respectfully, Albert W. Buel.
Cleveland, O., Nov. 7, 1893.

(We submitted a copy of the above letter to the Fox Solid Pressed Steel Co., of Chicago, and have received the following explanation.—Ed.)

Sir: Replying to your favor of Nov. 8, inclosing copy of a letter received by you in reference to the flat car exhibited by this company at the World's Columbian Exposition, while the car body is designed to carry a load of 100,000 lbs., the trucks exhibited under this car were, as a matter of convenience, of the lighter design, and when the car is placed in service we will place under it trucks having the proper sized journals for the increased capacity.

Yours truly, J. B. Brady.
Chicago, Ill., Nov. 14.

WATER SUPPLY AND DISEASE AT SAN REMO, ITALY.

Sir: Probably the best water to be found anywhere on the Riviera, if not the best in Europe, is that supplied to the town of San Remo, Italy. It is quite soft, very pure, greatly beyond the needs of the community in quantity and is furnished at very high pressure. The springs lie some 12 miles away among the mountains, are very carefully protected by masonry, and the water is piped directly to the consumers.

The present supply, which superseded the use of ordinary domestic wells, was introduced in December, 1883, at an expense of $160,000, the expenditure and ownership having been entirely assumed by Giovanni Marsaglia, an engineer who had much to do with building the southern approach to the St. Gothard tunnel. By contract, the city engages to take 1,000 cu. m. (264,200 gallons) daily for street and fire purposes, and pays therefor 30,000 fr. ($5,820) yearly. In 1973 the ownership of the works passes to the city without further remuneration. For private houses the water is metered, and the average rate is 100 fr. ($19.40) per year for each cubic meter (264.2 gallons) of daily supply.

Owing to the great excess of water over that required for the 18,000 inhabitants of San Remo, arrangements are now being made to supply the neighboring town of Porto-Maurizio from the same source.

The statistics showing the relation of water supply and death rate for San Remo are interesting:

	Total deaths.	Death rate per 1,000.
1879	362	22.37
1880	368	22.74
1881	320	19.75
1882	347	21.30
1883	441	26.91

	Total deaths.	Death rate per 1,000.
1884	312	18.91
1885	409	24.65
1886	334	20.10
1887	331	19.81
1888	270	15.90
1889	353	20.37
1890	307	17.34
1891	317	17.92
1892	352	19.83

Average for the five years before introducing public water supply, 22.61.

Average for the nine years since introducing public water supply, 19.65.

Still more striking are the typhoid fever statistics, which are upon the authority of Dr. Martemuci, the leading local physician. He says: "Where I now have one typhoid case, I had forty before the change in the water supply." William P. Mason.
San Remo, Nov. 1, 1893.

(It appears from the above figures that the yearly water rental paid by the city is equal to about 6⅓ cts. per 1,000 gallons, and that the private consumer who uses 264.2 gallons per day pays about 20 cts. per 1,000 gallons, meter measurement. The reduction of 2.96 per 1,000 in the death rate since the introduction of the public water supply is very significant, especially when taken in connection with the great reduction in typhoid fever cass. While a portion of the 13% reduction in the death rate was doubtless due to increased attention to sanitary matters, the improved water supply may safely be credited with a large part of this saving of life.—Ed.)

DEAN AND WOLHAUPTER BRAKE-PRESSURE REGULATOR.

Sir: In a recent issue of your valuable paper, describing the device of the Air-Brake Pressure Regulator Co. at the World's Fair, undue credit was given the writer by calling the device after his name. This company is manufacturing its devices under the patents of F. G. Susemihl, O. W. Dean, W. S. Jones and B. Wolhaupter. The devices described are chiefly under the patents of O. W. Dean and B. Wolhaupter. By inserting this correction in your paper you will confer a special favor upon

Yours very truly, Benj. Wolhaupter.
Sec. and Treas. A. B. P. R. Co.
Chicago, Ill., Nov. 9, 1893.

PROFILES OF NOTABLE ABT RACK RAILWAYS, WITH DETAILS OF OPERATION AND CONSTRUCTION.

(With inset.)

Since the first successful application of the Abt rack system to the railway from Blankenberg to Tanne, in the Harz Mts., Germany, it has been adopted for something over a score of the most notable mountain railways constructed in various countries and is now being installed or projected on perhaps a half a dozen more. Many of these lines have from time to time been more or less fully described in Engineering News and the principles of the system quite fully discussed. The greater extent to which mountain railways are now being constructed, however, and the favor with which this system has been received, and its mechanical advantages in many particulars over the ladder type of rack railways, first constructed by Sylvester Marsh, at Mt. Washington, New Hampshire, and afterward further developed by Riggenbach in Europe, make the twelve profiles of Abt mountain railways shown on our inset sheet of unusual interest. These illustrations have been reproduced from engravings accompanying a paper presented before Division B of the International Engineering Congress, in charge of the American Society of Mechanical Engineers, by Mr. Albert Schneider, of Germany (translated by Mr. W. Hildenbrand, C. E.). The following details have been obtained largely from the same source.

The principle of the Abt rack system has been so fully discussed in preceding issues of Engineering News that only a statement of the most salient features of the system will be made here. For the benefit of those who may wish more detailed information, however, the most important articles heretofore published in this journal are given in the accompanying footnote.* The general features of the principal Abt rack railways thus far constructed, including those illustrated on our inset sheet, are given in Table 1, and in Table 2 is given a similar list of the rack railways constructed on the Riggenbach system. Both of these lists are probably the most complete yet published, and with the profiles shown give a very good idea of the physical features of the notable mountain railways of the world.

The peculiarities of the Abt rack system lie both in the construction of the rack rail and in the construction and operation of the locomotive. In the Marsh or Riggenbach roads the rack rail consists simply of two parallel bars, angles or channels between which the teeth of round or trapezoidal iron are riveted or screwed like the rungs of a ladder. The cogwheel of the locomotive has evolute teeth, to minimize the shock, which work into the teeth of the rack. In the Abt system, however, this ladder-form of rack is not used, but the rack rail is multipartite with staggered teeth. In other words, the rail is formed of several bars, the number depending upon the tooth pressure, placed side by side with the teeth of each bar staggered with respect to those of the others. This system of bars, generally bipartite or tripartite, is carried on cast iron chairs bolted to the iron crossties of the track, to which are also fastened the adhesion rails. The bars are made in sections about 8 ft. long and it will be readily seen can be so arranged as to form curves in either direction and of any radius without any change in their construction. In the ladder system especially designed rails had to be made for each degree of curvature and for right and left curves. Moreover, owing to the decreasing area of contact between the teeth of the locomotive gear and those of the rack on sharp curves, it was necessary to use curves of large radius with the Riggenbach rack. With the staggered tooth rail of the Abt system, making it possible for several teeth of the locomotive gear to work simultaneously, and leaving no interval between the contact of two teeth, the area of contact on curves is practically the same as on tangents.

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* General explanation and discussion of the system, Dec. 26, 1885; description of Harz Mt. line and description of construction details, May 22, 1886; Bolan Rack Ry., India, June 16, 1888; Abt locomotives, Nov. 9, 1889; Pike's Peak Rack Ry., Dec. 7, 1889, April 19, 1890, Oct. 4, 1890; Monte Generoso Ry., March 9, 1889; Brienz-Rothorn Ry., Dec. 15, 1892; Cost and operating expenses, Dec. 22, 1892.

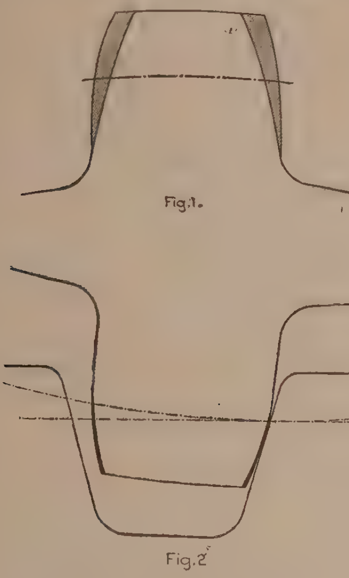
Fig. 1.

Fig. 2

Diagrams Showing Wear on Cog Wheel Teeth of Abt Locomotives.

The perfect contact of the gearing of course reduces the wear on the teeth of both the rack and the driving wheel. In Fig. 1 is shown the wear on one of the teeth of the driving wheel of the locomotive "Tanne," on the Harz Mt. road after running 68,380 miles, and in Fig. 2, the wear of the driving wheel teeth of a locomotive on the Eisenerz-Vordernberg road after one year's service with a locomotive mileage of 6,200 miles. The wear for Fig. 1 is given by Mr. Schneider as follows:

Years in use		7	
Locomotive mileage		68,380	
Original thickness of tooth	56	mm.	$2\frac{3}{16}$ ins.
Reduced " "	45	"	$1\frac{3}{4}$ "
Wear per year	1.57	"	$\frac{1}{16}$ "
Wear at Pitch Line:			
On each side of tooth	5.5	"	$\frac{7}{32}$ "
Total wear	11	"	$\frac{14}{32}$ "
Admissible wear on each side	8	"	$\frac{5}{16}$ "
" total wear	16	"	$\frac{5}{8}$ "
Wear per 1,000 km. or 6,200 miles	0.982	"	$\frac{5}{128}$ "

The Abt locomotive consists of two independent engines, one for the adhesion service and one for the rack service, and it works most economically if each of these engines can, at the proper opportunity, develop its full capacity. For this reason the profile of a road doing a large traffic should be so chosen that the adhesion traction will not be lost; that is, the grades should not exceed 6% or 7%.

TABLE I.—Showing Location, Construction and Equipment of Principal Abt Rack Railways Constructed Prior to 1894.

Name and location.	Gage, ft. in.	Length. R'ck rail, mls.	Length. T'tl, mls.	Max. grade. P. c. on. Ad-hes'n.	Max. grade. P. c. on. R'ck rail.	Max curves. Ad-hesion.	Max curves. Rack rail.	Locomotives. Constr'c'n R'ck whe'l or combinat'n r'ck and adhesion.	Locomotives. No.	Locomotives. When built.	Locomotives. Wt., tons.	Locomotives. Tractive pow'r, tons.	Train wh't, tons.	Mode of operating.
Harz Railway, Brunswick, Germany	4 8½	4.66	18.95	2½	6	9° 45′	8° 45′	R. & A.	5	1884–5	61	13	148	Pushing
Lehesten, Thueringia, Ger.	4 8½	0.81	1.68	3½	8	11° 30′	11° 30′	R. & A.	1	1885	25	6½	55	"
Oertelsbruch, " "	2 3⅛	0.43	3.11	5	13½	51°	17° 30′	R. & A.	2	1885	6½	2¼	8	"
Puerto Cabello, Valenzia, Venezuela	3 6	2.36	2.36	...	8	......	14°	R.	3	1886	46	10	66	"
Visp, Zermatt, Switzerl'd.	3 3⅜	4.66	2.17	2.8	12½	22°	17° 30′	R. & A.	5	1889–90	32	10	50	Pulling
Mt. Generoso, "	2 7½	5.59	5.59	...	22	....	29° 30′	R.	6	1889–90	16½	6	11	Pushing
Rama, Sarajewo, Bosnia, Austria	2 6	11.12	42.25	1½	6	14°	14°	R. & A.	8	1890	33	8	82½	Pulling
Eisenerz, Vordernberg, Styria, Austria	4 8½	9.01	13.05	2½	7.1	11° 30′	9° 45′	R. & A.	12	1890	61	13	132	Pushing
Manitou, Pike's Peak, Col.	4 8½	9.32	8.80	...	25	....	16°	R.	4	1890–2	25	12	20	"
Transandine, Chile, S. A.	3 3⅜	17.40	31.07	2½	8	15° 15′	8° 45′	R.	6	1890–1	46	9	66	"
Diakophto, Kalavryta, Greece	2 5½	2.24	14.29	3½	14½	61°	35° 30′	R. & A.	3	1890–1	17½	5½	17½	Pulling
Rothorn, Switzerland	2 7½	4.66	4.66	...	25	....	29° 30′	R.	4	1891	18½	8	10	Pushing
Glion, Naye "	2 7½	4.66	4.66	...	22	....	22°	R.	6	1891	18½	8	11	"
S. Domingo, West Indies	2 6½	3.98	22.37	4	2	35° 30′	17° 30′	R. & A.	4	1891	27½	8	55	Pulling
Mt. Saléve, Savoy (electr.).	3 3⅜	5.59	5.59	...	25	....	51°	R.	14	1891–2	7½	3	11	Pushing
Wami, Toge, Japan	3 6	5.28	12.43	2½	6.7	....	6° 40′	R. & A.	4	1891–2	39⅛	11	110	"
Aix-les-Bains, Revard, Savoy	3 3⅜	5.72	5.72	...	21	....	23° 30′	R.	8	1891–2	20	8	11	"
Montserrat, Spain	3 3⅜	4.97	4.97	...	15	....	22°	R.	5	1891–2	18⅛	8	10	"
Schafberg, Austria	3 3⅜	3.73	3.73	...	25½	....	17° 30′	R.	3	1892–3	20	8	22	"

In operating the rack locomotives considerable more care has to be taken than in operating the ordinary adhesion locomotive. The following description of their operation on the Harz Mt. road will with but very little modification apply to any of the roads using this system. In running up grade before the locomotive enters the rack rail from an adhesion line, the engineer opens a little the throttle of the rack engine, setting the cog wheels slowly into motion before the locomotive reaches the entering rail. The cog wheels would come into correct contact with the rack teeth even without previous motion, but when they are slowly revolving the entering is smoother and more noiseless. As soon as the locomotive is fully on the rack rail, the engineer works the rack engine with all its power, and when the locomotive comes near the end of a rack rail, the throttle of the rack engine is closed to prevent the cog wheels from revolving when directly over the entering rail, in order to avoid an unnecessary noise by their possible striking against the shortened and rounded teeth of the latter.

The down grade motion is regulated by air compressed in the steam cylinders. Before going down the steam of the rack engine is shut off, and the locomotive proceeds with the adhesion engine alone to a point where the train would begin to descend by its own gravity. Immediately on reaching this point the valve gear is reversed, so that the motion of the adhesion engine is contrary to the motion of the locomotive. This sets the adhesion air-brake in operation, with which the speed of the train is regulated. Shortly before entering a rack line, the engineer sets the rack engine slowly into motion in the same direction as the motion of the locomotive, but as soon as the entering has fully taken place the throttle of the rack engine is closed immediately, and at the same moment the valve gear is reversed in order to work the air-brake of the rack engine, which combines with the adhesion air-brake for regulating the speed. The proportionate work of the air-brakes of the two engines is regulated in the same way as the steam pressure is proportioned during the up trip, hence on grades where the rack engine works to its full capacity in going up, the rack air-brake must work to its full capacity in going down, and the adhesion air-brake assists only to the capacity of the adhesion friction. When the locomotive comes near the outlet of a rack rail, the efficiency of the adhesion air-brake must be enhanced, and the valve gear of the rack engine must be reversed so that its motion is in the same direction as the motion of the train. This can be done without endangering the descent, because the ends of all rack grades and the adjoining ends of the adhesion grades are so arranged that the adhesion air-brakes alone are sufficient for holding the train.

With these precautions the safety on rack roads in spite of the steep grades, is almost absolute. No accident is on record on any of the large rack roads. In going up grade the speed on the Harz Mt. road is about seven miles per hour on the rack, and in going down it is limited to 6.2 miles per hour. In regard to snow it is stated that by the use of snow plows ordinary depths of from 18 ins. to 2 ft. give no serious trouble. The rack rail, judging from such information as can be obtained, is a decided advantage in operating with snow on the track. On the Harz Mt. road and on rack roads quite generally the locomotive is placed at the lower end of the train and pushes it up grade. Additional safety is thus secured, since the drawbars are generally a weak point in European cars. The admissible weight of trains on the Harz Mt. road is 148 tons, and they are generally made up in any way desired, except that, as they are all mixed trains, the passenger, mail and baggage cars are grouped together and separate from the freight cars. With a train of 148 tons exclusive of the locomotive, the pressure on the teeth of the rack is 15,400 lbs.

Table 2.—Showing Location and Construction of Riggenbach Rack Railways Built Prior to 1894.

Name and location.	Length, miles.	Max. grade, p. c.	Gage. ft.	Gage. ins.	Mode of operation.
Mt. Washing'n, N.H.	3.29	37	4	8½	Rack
Vitznau, Rigi, Switzerland	4.35	25	4	8½	"
Ostermundingen, Switzerland	0.93	10	4	8½	Rack and adhesion
Kahlenberg, Austria	3.11	11	4	8½	Rack
Rorschach, Heiden, Switzerland	3.42	9	4	8½	"
Arth, Rigi, Switzerland	5.59	21	4	8½	"
Wasseralfingen, Germany	1.24	7.8	3	3⅜	Rack and adhesion
Rüti, Switzerland	0.31	10	4	8½	" "
Lauffen, Switzerland	0.19	5	4	8½	" "
Friedrichshegen, Germany	1.55	10	3	3⅜	" "
Green Mt., Mount Desert, Maine	3.73	25	4	8½	Rack
Petropolis, Brazil	4.35	15	3	3⅜	"
Corcovado, Brazil	2.17	30	3	3⅜	"
Drachenfels, Germany	1.24	20	3	3⅜	"
Rüdesheim, Germany	1.49	20	3	3⅜	"
Degerloch, Germany	1.24	17.2	3	3⅜	"
Zakarotz, Hungary.	3.42	8	3	3⅜	Rack and adhesion
Assmannshausen, Germany	0.93	20	3	3⅜	Rack
Naples, Italy	0.50	7	3	3⅜	"
Gaisberg, Austria	3.42	25	3	3⅜	"
Langers, France	0.93	17	3	3⅜	Rack and adhesion
Sumatra, Asia	18.64	12	3	3⅜	" "
Brünig, Switzerland	9.94	12	3	3⅜	" "
Höllenthal, Black Forest, Germany	21.75	5.3	4	8½	" "
Peterberg, Germany	0.81	26	3	3⅜	Rack
Ienbach, Germany	2.05	16	3	3⅜	"

Some figures as to the cost of operating rack roads were given in our issue of Dec. 22, 1892, and Mr. Schneider gives the income and expenses from operations of four of the lines described in the accompanying tables. Owing to the difference in the character of the data given for the various roads, however, about the only comparison of any use which can be made is of the expenses per train-mile.

*Righi	$2.16
*Pilatus	2.42
Generoso	1.06
**Utliberg	.66
Harz	1.05
*Hoellenthal	1.02
Eisenerz-Vordernberg	1.36

*Ladder system. **Adhesion only, 7% grade.

Of course any comparison between the stated expenses per train-mile of different roads of different character is of very little value unless the controlling circumstances are given. Taking, however, the official figures of the Austria-Hungary railways, which will probably not vary greatly from those of other European countries where mountain railways are most common, we find the expenses per train-mile given at 92 cts. This indicates roughly the increase in operating expenses due to the heavier grades and the rack system.

Judging from such figures as are given of the coal consumption of the Harz Mt. road, the increase due to the rack system and steep grades is about 50%. This road uses exclusively coal from the Dalhausen mine, Westphalia, which is noted for its good quality. One pound of this coal evaporates 11 lbs. of water, and the average consumption on the Harz Mt. road during the year 1891 was 62 lbs. per train-mile. On the adhesion road from Halberstadt to Blankenberg, the lower terminus of the rack-adhesion line, the consumption of the same kind of coal is 41.3 lbs. per mile. The maximum grade is 1%.

The locomotives of the Eisenerz-Vordernberg road required 89¾ lbs. of Frohndorf coal or 79½ lbs. Libuschin coal per train-mile, but 1 lb. of the former coal evaporates only 5.39 lbs., and of the latter 6.07 lbs. of water. If Dahlhausen coal was used on this road, Mr. Schneider states that the average consumption would be 71 lbs. per train-mile, which is a little more than on the Harz road on account of steeper grades and proportionate smaller lengths of the adhesion lines.

Probably the most important railway on the Abt system, at present in course of construction, is between Beirut and Damascus, in Syria. The total length of this road will be 87 miles, 18.6 of which will be provided with a rack rail for ascending and descending the Lebanon Mts., which extend between the two named cities. The gage will be 3 ft. 5¼ ins.; the steepest adhesion grade will be 2½%, and the steepest rack grade 7%. The total cost of the road has been estimated at $6,000,000, or at $68,957 per mile. A new project, promoted by the banking firm Morson, of Lausanne, has been worked out by Mr. Chappius, C. E., for crossing the Simplon Pass from Brieg, in Switzerland, to Domo Dossola, in Italy. The gage is to be standard; the steepest grade will be 6% for rack service and 2½% for adhesion service. The smallest radius for curves has been limited to 656 ft. This road, if built, will be especially interesting for being operated with electric motors, for which the Rhone and Cairasca rivers are to furnish the power. The road will have a length of 31 miles, and its cost is estimated at $8,000,000, or $257,640 per mile.

PRODUCTION OF HEAVY STEEL FORGINGS IN THE UNITED STATES.*

By Russell W. Davenport, Second Vice-President Bethlehem Iron Co.

Five years ago there was no forging plant in the United States equipped with suitable facilities for the production of the heavy steel forgings required either in the construction of modern marine engines and cannon of the larger calibers or for forged armor plate. Heavy shafting, cranks, connecting rods, etc., for stationary or marine engines, had, in general, been made of wrought iron, and a high degree of skill had been attained in a number of forges in the production of pieces of large dimensions. Thus the very heavy forgings used in the engines of the great sound, river and lake steamboats were, for the most part, made of wrought iron. Forgings of wrought iron have a low elastic limit, probably averaging in large masses not over 20,000 lbs. per sq. in., and while, when proper care is taken in their production, a high degree of toughness and uniformity can be attained, the danger of imperfect welds and the occurrence of porous spots inclosing slag and scale are always a menace to the uniform strength so desirable in such pieces. The probability of the occurrence of such imperfections increases with the dimensions of the forgings.

The fact that it was possible to make large forgings of steel greatly superior in uniformity and strength to those of wrought iron was early recognized; but as long as steel was made by the crucible process and was melted in pots or crucibles containing from 60 to 90 lbs. apiece the production of the larger ingots required for heavy forgings presented difficulties which few cared to meet, while the cost of such forgings was necessarily so high as to oppose their general use in machine construction. Fried. Krupp, of Essen, was the pioneer in producing large masses of crucible steel, and in the London exhibition of 1851 he surprised the steel makers of the world by exhibiting a crucible steel ingot weighing about 5,000 lbs., and at Vienna, in 1873, an ingot weighing 115,000 lbs. was exhibited by the same firm. The skill and courage with which this branch of manufacture was developed at the Essen works were extraordinary, and even at the present time large numbers of heavy gun and shaft forgings are thus made of crucible steel. Krupp's lead was followed to a considerable extent by the Sheffield and other English crucible steel makers; but in the production of such forgings of crucible steel the Krupp works have always excelled both as to dimension and quality.

While many forgings of moderate size have been made of steel produced by the Bessemer process, this process has never proved to be well adapted to the casting of heavy ingots, owing to the fact that the usual charge of a Bessemer converter does not exceed about eight tons of steel, and that the arrangement and equipment of several converters for the advantageous production of smaller ingots is not well adapted to combining their several charges in one large mold.

With the introduction and development of the open-hearth process it was soon recognized to be well suited to the production of large masses of steel, for metallurgical and mechanical as well as economic reasons. A uniform product can be obtained, the composition of which is under good control. The product of several furnaces can be conveniently united in one mold, and large masses of scrap steel cut from forgings can be remelted.

The French works led in the development of the open-hearth process in this direction, and as early as 1877 possessed at the Creusot works an open-hearth plant capable of casting an ingot weighing 110 tons, together with a 100-ton hammer for forging the same. This masterly plant was especially adapted to the forging of all-steel armor plates, which were first manufactured as a regular product by the Creusot Co.

The production of heavy open-hearth forgings also made rapid progress in England, but as the manufacture of forged steel armor plate was not there attempted, no hammer of over 40 or 50 tons falling weight was constructed. The firms of Vickers & Co. and Charles Cammel & Co. may be mentioned as among the best known producers of heavy open-hearth forgings for guns and shafting, which, until recently, were made under the hammer, and the Vickers Co. is especially noted for its marine engine forgings.

It lay, however, with Sir Joseph Whitworth & Co., of Manchester, England, to lead not only England, but the world in the art of making open-hearth steel forgings (except for armor plate). This advance consisted in two distinct improvements: First, in subjecting the fluid steel immediately after casting, and during solidification, to a heavy hydraulic pressure, usually known as fluid compression, by which means "blow holes" and cracks are obliterated and the piping and seggregation reduced to a minimum; and, second, the substitution of the hydraulic press for the hammer as a forging machine. This substitution brought with it many advantages, among which the most important is the forging hollow on a mandril of long lengths suitable for gun tubes, jackets and all descriptions of shafting, etc. A farther reference will be made to these hollow forgings.

In the United States, as already stated, little progress had been made up to within five years of the present time in providing facilities for the manufacture of the heavier class of steel forgings. There were in operation a number of hammers of medium power, ranging from 9 to 17 tons falling weight; and forgings of corresponding size, weighing about 10 or 12 tons and below, had been produced in considerable quantities. We were, however, entirely dependent upon European establishments for our supply of steel forgings of large weight and dimensions.

The Midvale Steel Co., at Nicetown, Philadelphia, had made a good beginning in the production of forgings of excellent quality for modern steel guns of 6-in. caliber and below, and had succeeded in producing one set of forgings for an 8-in. army gun. About two years since this company completed the erection of a hammer of about 40 net tons falling weight, and thereby so increased its forging facilities as to warrant contracting with the War Department to furnish forgings for 10-in. and 12-in. cannon.

It was in 1885 that the managers of the Bethlehem Iron Co., foreseeing in the near future the demands of the country for heavy steel forgings, determined to establish a forging plant of the first order. A survey of the field led them to believe that the machinery and methods developed and used by Sir Joseph Whitworth & Co. for the manufacture of gun and machine forgings resulted in a product superior in quality to any other known. Through the skillful efforts of Lieut. W. H. Jacques, then of the U. S. Navy, the personal objections of Sir Joseph Whitworth to the duplication of his plant for use in other establishments than his own had been overcome, and in January, 1886, a contract was entered into by the Bethlehem Iron Co. with Sir Joseph Whitworth & Co., Limited, for the supply of a large amount of machinery as well as information. The principal items covered by this contract were as follows:

Two hydraulic forging presses complete, with engines and pumps, one of 1,500 and one of 4,500 tons capacity, together with two Whitworth hydraulic traveling forging cranes and other necessary appliances for each press; a complete fluid compression plant, including a press of 7,000 tons capacity and a 125-ton hydraulic traveling crane for serving it (the upper and lower heads of this press weighing respectively about 135 and 120 tons, were made at the Bethlehem works); some large machine tools, such as lathes and boring mills, typical of the best development in their respective classes; also designs of open-hearth furnaces and special tools, and an agreement to impart to a practical representative of the Bethlehem Co., to be sent to the Manchester works, full information as to methods and shop practice. There was also a provision that skilled men should be sent by the Whitworth Co. to Bethlehem to superintend the erection and starting of the new machinery. Of this provision, however, the Bethlehem Co. did not avail itself, but erected and put the plant in operation with its own employees, unaided, except by such information as had been gathered by the representatives of the company that had visited the Whitworth establishment. An important feature in the agreement was that all the machinery furnished should represent the latest experience of the Whitworth Co. and should be equal in design and execution to similar machinery built new for their own works; it is believed that this agreement was strictly carried out, thus making the Bethlehem plant superior in many respects to the one at Manchester. The money value of this contract was very great, and has rarely, if ever, been exceeded by that of a single order given out by a private concern; this, of itself, is the best proof of the courage and enterprise of the management of the Bethlehem Co.

While the new machinery was being made at Manchester, buildings of ample proportions were prepared for its reception at Bethlehem; a very fine plant of four open-hearth furnaces of a united capacity of 110 to 120 tons was projected and in part completed, and a machine shop of truly grand dimensions was erected and partly equipped with tools, of which some far exceeded in power and capacity any that had before existed in this country, and of these some of the heaviest were constructed in the Bethlehem shops.

When, therefore, in 1886, Secretary of the Navy Whitney asked American manufacturers to bid on about 1,300 tons of steel forgings for heavy cannon and 6,700 tons of steel armor plate, bids to be opened March 22, 1887, the Bethlehem Co. was already well advanced in its preparation to undertake the manufacture of the former. As is well known, the Bethlehem bids were accepted for both classes of forgings, and contracts for the same were signed in May and June, 1887. Work on the hydraulic forging plant and accessories was pushed with great vigor, and, although the delivery of the machinery ordered of Whitworth & Co. was delayed far beyond the dates agreed upon, the first forgings for guns and shafting were produced in the autumn of 1888.

In the meanwhile, preparations had to be made for the production of armor plate, which was an undertaking of far greater magnitude and much more involved with uncertainty and risk than the manufacture of gun and marine engine forgings. The contest between the English compound and the French all steel armor had been going on in Europe for some years, with results which had led to the adoption of all steel plates by our Navy Department. The contract with the Navy Department did not specify that the heavy armor should be forged rather than rolled, but, as already stated, Schneider & Co., of Le Creusot, France, who had developed this armor and who were at that time the only makers of it, produced all plates above 6 ins. in thickness by forging under a 100-ton hammer, and it was known that our Navy Department preferred and expected that the same method be followed. The Bethlehem Iron Co. had decided to pursue the same course as regards armor as it had done in the case of other classes of forgings, viz., to obtain full information as to the best existing methods of production, and so begin the manufacture in this country at the most advanced point then reached in Europe. A contract had previously been entered into with the Creusot Co. by which it agreed to furnish all necessary drawings of machinery and full information as to manufacturing methods and shop practice, and also granted rights to manufacture under all patents covering armor plates. It will be readily understood that, under the circumstances then existing, such a contract was not entered into by Creusot without a heavy compensation, which has been no small part of the burden to be borne in introducing this new industry into the United States.

The new plant was, in general, modeled after the one at the Creusot works, but, in detail, a number of modifications and improvements were introduced with a view of increasing its capacity and adding to its convenience; thus the falling weight of the hammer was increased from 100 to 125 tons; the length of face of forging dies from 6 ft. 6 ins. to 10 ft.; the steam pressure from 75 to 125 lbs; the valve motion was immensely improved and hydraulic traveling cranes were adopted instead of power swinging cranes. The bending press was improved in many particulars, and important modifications were made in the tempering plant.

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* A paper read at the New York meeting of the Society of Naval Architects and Marine Engineers. Copyrighted 1893. Published by permission of the Society.

For many reasons, the construction of the whole plant, with the exception of most of the machine tools for trimming plates, was undertaken by the Bethlehem Co. The difficulties of transporting the large number of very heavy parts required and the import duties on such a great weight precluded purchase in Europe, while no concern in this country would have cared to undertake the work, except at a very high price to cover the cost of special preparations and risk, as well as the difficulties of transportation. The Bethlehem shops, on the other hand, had better facilities than any other in this country for executing work of this magnitude, and also had experience and special knowledge which it would have been poor policy to place at the disposal of other manufacturers.

Difficulties were encountered and time lost in finding the best site for the hammer foundation, and the beginning of construction was retarded by the delay in the receipt of forging presses and machine tools from Whitworth & Co.; nevertheless, when work was commenced, it was pushed with such vigor as to be completed within a considerably shorter time than predicted by the Creusot engineers, and the first armor plate was forged in the summer of 1891, or something over two and a half years after actual work on the plant had been begun. The modifications and improvements in design have proved fully as advantageous as expected, and this plant stands to-day at the head of any of the great hammer forges in the world.

While the hammer was being built, the forging presses were in constant operation, and the experience gathered therefrom led the Bethlehem management to the conclusion that in order to make the forging capacity of the works meet every probable requirement in the most satisfactory manner, a larger forging press was desirable. As a result, a double cylinder forging press of 14,000 tons capacity, with pumps driven by 15,000 HP. engines, were designed by Mr. John Fritz, the general superintendent and chief engineer of the company, and Mr. E. D. Leavitt, acting as consulting engineer for engines and pumps. This press is now completed and constitutes, with its furnaces of large dimensions and hydraulic traveling cranes, the most complete and powerful forging apparatus yet in operation.

From an engineering point of view, this great work is the creation of Mr. John Fritz (who until recently was mechanical engineer and general superintendent of the company), and is a fitting monument to his mechanical genius and untiring energy. As a business enterprise it is none the less a notable accomplishment, and testifies to the faith and pluck of the board of directors and their general manager, the late Dr G. B. Linderman, who, in the face of the magnitude of the undertaking and its uncertainties, had entered into engagements for buildings and machinery involving more than $1,000,000, nearly one year before the government had advertised to receive bids for gun forgings and armor plates; nor have they ceased to add other millions year by year to bring this work to its present state of efficiency. It is a subject of congratulation not only to the government of the Bethlehem Co. but to American manufacturing interests, that while the establishment of this plant has been of national importance, it has been accomplished entirely without government aid, for the award of government contracts has been made in open competition to the lowest bidder, and subject to specifications and conditions more severe in many respects than ever before imposed in this or any other country.

Having outlined the development of plant in the United States for the manufacture of heavy steel forgings, a few remarks may be of interest in relation to the conditions necessary and the most improved methods employed for producing uniformly reliable forgings of such quality as to offer maximum resistance to working strains. The subject may be divided as follows: (1) The casting of ingots; (2) the conditions of shaping or forging; (3) treatment after forging; (4) the introduction of unusual ingredients into the composition of the steel intended to give to it desirable qualities.

Casting of Ingots.

There are certain defects which are likely to occur in all steel ingots. They are of more frequent occurrence and more serious in their nature as the ingots increase in weight and dimensions. In general, they are developed during the solidification and cooling of the fluid steel, and are, for the most part, caused by the great change of temperature which then takes place. They can be classified as follows: (1) Interior shrinkage, or "piping," caused by the outside of the ingot cooling more rapidly than the inside and producing cavities and a porous condition of metal along the central axis, or line of last cooling. These defects assume serious proportions and concentrate within conical lines in about the upper third of the ingot. (2) Blowholes, or cavities, due to the evolution of gas during cooling and solidification, which, under certain conditions of melting and composition occur throughout the mass, but especially near the surface and toward the upper part of the ingot. (3) External, or surface cracks, caused by the rapid shrinkage of outside or skin of ingot, and at times due to hydrostatic pressure of the internal and fluid portion. (4) Internal cracks, due to interior strains set up by too rapid cooling and occurring most frequently in ingots of hard steel. (5) Segregation, which is the name given to the change which takes place in the chemical composition of a mass of steel in cooling, and is due to the liquation or concentration of certain ingredients, principally carbon, phosphorus, sulphur, and, to a less degree, silicon and manganese, toward the central and upper portion of the ingot, where cooling and solidification of the metal last takes place.

A number of expedients are resorted to in ordinary practice, with more or less success, for controlling and avoiding these defects; but, without doubt, the most efficient of all methods is the application of the Whitworth process of fluid compression. At the Bethlehem works this process is in daily use in the production of large ingots for gun, shafting and miscellaneous machine forgings, and masses of steel of great weight are thereby produced, which are to a high degree sound and homogeneous, and which, when prepared by boring for hollow forging, are practically free from all defects.

Conditions of Shaping and Forging.

When a mass of steel is to be shaped or forged, the first requisite is careful and uniform heating to a proper temperature; this is greatly a matter of experience and skill and requires unremitting care and attention. The next requisite, and one of the first importance, in order to obtain reliable results, is the use of forging machinery of proper design and power for the work in hand. The presence of internal strains and defects, causing failure of many forgings, can be attributed to the shaping being done with hammers of insufficient power, and especially if the power is developed by a high velocity of impact, rather than by weight of falling mass.

The pressure applied in shaping a body of steel should be sufficient in amount and of such character as to penetrate to the center and cause flowing throughout the mass; this flowing of the metal requires a certain amount of time, and, therefore, the requisite pressure should be maintained during a corresponding period, in order to insure thorough action. The quick blow of a hammer of insufficient power is absorbed near the surface of the mass struck, and there causes a local movement or extension; and repeated blows of this description, stretching the exterior more rapidly than the interior, bring a tearing strain on the core, or central portion, producing at times actual cavities, which are defects of the most dangerous kind. This action is visibly demonstrated by the ends of forgings made under the conditions last named, assuming a concave or cupped form, due to the exterior drawing more rapidly than the central portion.

The conditions of forging attained by the use of the hydraulic press are evidently the reverse of those above mentioned, and are correspondingly favorable to obtaining the best results. The pressure is definite and constant, and acts slowly but uniformly throughout the distance traversed by each stroke. As a result, there is ample time for the pressure to distribute itself, and, if sufficient in amount, it causes flowing throughout the entire section operated upon, the tendency being to squeeze out and extend the central portion even more rapidly than the exterior. A similar effect is attained, though to a less degree, by the use of a hammer developing ample power for the work to be done, especially when the power is due to a great weight falling by the force of gravity only, and thus reducing the velocity of impact to a minimum. The action of the forging presses in the Bethlehem shops fully substantiate the theory as above indicated, and no forgeman can observe the actual slow but continued flowing of the metal throughout the section and the central bulging at the ends without knowing the shaping is being done under the most favorable conditions. The increase of the falling weight of the great Bethlehem hammer to 125 tons, as already mentioned, was an eminently wise step as insuring, to a considerable degree, conditions similar to those above described, even when forging the ingots of the great weight and section required for heavy armor plates. The thoroughness of the work done is indicated by the comparatively small number of blows required to effect the reduction in area and by the bulging convex shape of the ends of plates.

A most important factor in the use of hydraulic presses for forging is the ability to produce with them long lengths forged hollow over a mandril, and this class of forgings is especially adaptable to marine shafting and the parts of built-up guns. In the manufacture of hollow forgings the conditions of shaping are in all respects favorable to the production of sound work of the highest quality. A hole of suitable size is bored throughout the central axis of the unforged ingot, thereby removing the portions rendered defective by segregation and "piping" and disclosing any interior defects that may not have been removed by boring. The bored ingot forms a hollow cylinder with walls much thinner than the cross-section of the solid ingot; this condition greatly facilitates heating and practically removes the danger of internal cracking during that operation. The forging of the comparatively thin walls of the cylinder over a solid mandril also insures thorough work and makes it possible to turn the forging out at a low and uniform heat, thus fixing a uniformly fine or amorphous grain. A solid forging, on the other hand, of the same outside diameter, would be much hotter toward the central axis than on the outside, and a gradual loss of this high internal heat will tend to coarsen the grain by crystallization and set up internal strains. In the hollow forgings any internal defects show themselves on the inner surface, while in solid forgings their presence is hidden and can only be disclosed by boring.

Treatment After Forging.

There are two processes usually employed in the treatment of steel forgings after they leave the press or hammer, viz., annealing and tempering, or hardening, or a combination of the two. To these must be added surface or case-hardening, which, while heretofore frequently used in the treatment of small forgings, has recently come into prominence on a large scale in the application of the Harvey and other processes to the production of hard-faced armor plate.

The primary object of annealing is to relieve internal strains set up by forging and by rapid and irregular cooling during and after forging. In addition to this, annealing alters the molecular condition of the steel, and when applied under proper conditions has a tendency to break up crystallization and fix a finer or more nearly amorphous grain, whereby the toughness of the material is increased. The general effect of annealing, as indicated by the tensile and elastic specimens, is to lower the tensile strength and elastic limit and increase the elongation and contraction of area.

Hardening or tempering of steel forgings consists in cooling them rapidly, usually by immersion in oil, from a red heat varying in degree according to conditions, and hence it is generally spoken of as oil tempering. The object of this treatment is, first, to break up the irregular and more or less laminated and coarse crystalline structure produced by forging, and to fix a fine or amorphous condition of grain: and, second, to modify the physical properties of the metal, with a view of obtaining the most desirable combination practicable.

The sudden cooling in oil or otherwise naturally produces strains which, unless properly guarded against and relieved, are hurtful, and, under certain conditions, may be so great as to cause actual rupture. To avoid this latter danger, precautions both as to shape and composition are necessary, but of first importance is the removal, when possible, of the metal along axial lines before tempering, so as to effect internal as well as external cooling. This must often be done by machining, but it is evident that forging hollow furnishes a product especially well adapted to tempering. Annealing is resorted to after tempering: first, to relieve strains, and secondly, to soften the metal to a degree required to obtain the physical qualities aimed at. The effect of this double treatment, tempering and annealing, is indicated by tensile tests, is in general to increase the elastic limit relatively to the tensile strength, and, when the hardness is "drawn" by annealing, to increase materially the elongation and especially the contraction of area.

Treatment by tempering has been applied in the manufacture of steel gun forgings and armor plates for a number of years with highly satisfactory results, and the great amount of testing, by breaking specimens cut from full-sized prolongations of the actual forgings after treatment, required in gun steel and armor plate specifications, has provided such a mass of information bearing upon the effect of this treatment on various grades of steel as to enable the manufacturer to obtain with great precision certain specified qualities in tempered material. Comparatively little has been as yet done toward the treatment by tempering of marine shafting and engine forgings; but it is believed that with the growing importance of decreasing the weight and increasing the strength of such forgings, a large field for improvement is open in this direction to the marine engineer.

Introduction of Unusual Ingredients.

The introduction into steel of ingredients other than those usually present, for the purpose of imparting to the metal desirable physical qualities, is a subject which has called forth much experimental work and study.

Results of practical value have been obtained with chromium, tungsten, manganese (in more than usual quantities), aluminum and nickel, and some experiments have been made with copper.

Chromium and tungsten, in moderate amounts, are, for the most part, used in high carbon crucible steels, to which they impart special hardening properties found useful for cutting tools. Chrome and tungsten steels, especially the former, have also of recent years been brought into prominence by their successful application to the manufacture of armor-piercing projectiles, and a considerable amount of chrome steel is now produced in open-hearth furnaces.

Manganese, when introduced in considerable quantities, say from 3 to 15%, imparts to steel remarkable toughness together with such great hardness as to render machining impracticable, and its useful application is therefore limited.

Aluminum in small quantities acts in a remarkable manner to increase the fluidity of steel when cast, and prevents the formation of blowholes during solidification, and has, consequently, found wide use in the production of solid steel castings.

The introduction of nickel into steel, while only of recent development, has been found to impart to the metal highly desirable qualities, and as this alloy, containing definite proportions of nickel, can be successfully and uniformly produced by the open-hearth process, it is especially applicable to the classes of large forgings now under consideration. The physical properties of the alloys of nickel and steel were first brought to general public notice in an admirable paper by Mr. James Riley, of Glasgow, published in the "Journal of the Iron and Steel Institute," Vol. I., 1889.

Experiments in the use of nickel-steel for armor plates were soon after undertaken by the Creusot works, and were so successful that during the winter of 1890, Schneider & Co. were ready to submit a plate of nickel-steel for public trial. The probable superiority of nickel-steel for armor had been early brought to the attention of the Navy Department, and in 1890 Secretary Tracy authorized the purchase from the Creusot Co. of two experimental 10½-in. plates, one of simple and one of nickel steel. A Cammel compound plate of same dimensions was also procured, and in September of the same year the famous comparative trial of the three plates above named took place at the Annapolis Proving Ground. As is well known, the nickel-steel plate proved superior to the others, especially on account of its freedom from cracks. As a result of this trial, nickel-steel was adopted for the armor of the navy. The production of nickel-steel was undertaken by the two firms having contracts for armor, viz., the Bethlehem Iron Co. and the Carnegie Steel Co., Ltd., and within a year after the above-mentioned trial successful results were obtained. Since then nickel steel armor plates have been regularly produced in large quantities.

The physical properties of nickel-steel vary greatly according to the amount of nickel contained. A steel containing about 3¼% of nickel has, up to the present time, been generally used for armor plate, and much information as to its qualities has been obtained. In general, the presence of this amount of nickel (3¼%) increases the hardness, i. e., the tensile strength and elastic limit, without causing a corresponding reduction in elongation and contraction; and the elastic limit is also increased relatively to the tensile strength. These properties indicate toughness.

The presence of this amount of nickel appears also to hinder crystallization after forging and favors a finely granular or amorphous condition. It also renders the steel more susceptible to the effects of tempering, and it is in tempered steel that the improved qualities are more apparent. As shown by the ballistic tests of armor plate, the presence of nickel materially increases resistance to shock, and, in short, in all respects improves the physical qualities of mild steel.

From the above it is evident that the use of nickel-steel should not be confined to armor plate, and that a wide field of application is open to it in the fabrication of gun and marine engine forgings, as well as many other products. In conclusion, it may be of interest to summarize, from a metallurgical point of view, the present status of the manufacture of the three classes of steel forgings under consideration, and to indicate the lines in which improvements can be made.

Gun Forgings.

The high working strains to which modern heavy ordnance is subjected has called for the highest attainable qualities in the material of which the parts are made. To insure this end, the specifications governing the manufacture of gun forgings have been drawn with great care, a large number of test specimens cut from the actual forgings after final treatment are required to show uniform and high physical qualities, and the manufacture is subject to constant and thorough inspection. The result is that the steel for gun forgings is melted of the best obtainable material; ingots are cast with special care to avoid cracks, blowholes and other defects, hollow forging is practiced whenever possible, and tempering and annealing are universally applied. In short, all the resources of the steel maker's art have been called upon to insure a perfect product in which the highest attainable physical qualities have been developed. As steel gun forgings have, up to the present time, been in general made of simple steel, improvements in physical qualities, to meet the demands of higher working pressures, must be looked for in some steel alloy. Chrome has been used to a limited extent for parts of small dimensions where great hardness and high elastic limit are aimed at, as in the Brown segmental gun; but nickel offers the best promise of improvement in the physical qualities of gun forgings. A complete set of forgings for an 8-in. gun has been made by the Bethlehem Iron Co. for the Bureau of Ordnance, U. S. Navy, of nickel steel, and are now being assembled at the Washington Navy Yard. The average physical qualities obtained in these forgings in transverse specimens, 2½ ins. diameter and 2 ins. long, were:

	Tensile strength.	Elastic limit.	Extension.	Contraction of area.
	—Lbs. per sq in.—		—per cent.—	
Tube	93.200	58,300	21.2	42.0
Jacket	99,900	60,000	20.4	45.9
Hoops	109,100	68,200	20.5	46.9

As compared with an average of qualities usually obtained in corresponding navy gun forgings, made of simple steel, the tensile strength shows an increase of about 10%, and the elastic limit an increase of from 22 to 28%; the elongation and contraction of area are but slightly reduced. It is believed that by modifying the composition of this steel, a considerably higher tensile strength and elastic limit can be obtained without dangerous sacrifice in ductility.

The Ordnance Department of the army have also ordered a tube for a 12-in. gun, Model 1892, to be made of nickel steel. The physical qualities guaranteed in transverse specimens 9-16 in. diameter and 3 ins. long, are as follows: Tensile strength, 85,000 lbs. per sq. in.; elastic limit, 53,000 lbs. per sq. in.; elongation, 18%; contraction of area, 35%, which is an increase of 9% in tensile strength, 26% in elastic limit, 6% in extension, and 17% in contraction of area over the usual minimum requirements.

It is thought probable that tubes of nickel steel may offer an increased resistance to erosion of bore as compared with simple steel, and it is hoped that more extended experiments will be made to determine this important point.

Armor Plate.

The remarks made regarding the high standard aimed at in the manufacture of gun forgings are also applicable to that of steel armor plate. "The best is none too good" is a safe motto. Besides meeting certain physical requirements in specimens taken from the plates, the manufacturer has to guarantee a successful ballistic trial of any plate of a group which the inspector may choose to select; and as the financial loss in case of failure may be very great, it is evident that every possible care must be taken to perfect and control the manufacture. The ballistic acceptance test of armor for the U. S. Navy is more severe than that demanded in any other country.

Forged armor plates made of simple steel, as originally developed by the Creusot works, offered a much greater resistance to penetration than wrought iron or even compound plates when attacked with steel armor-piercing projectiles, but the vice of the all-steel plate lies in cracking, and it was the introduction of nickel into the steel, as already stated, which to a great degree corrected this defect.

It is probable that an increased resistance to penetration may be obtained by the introduction of other metals along with nickel, and at the St. Chamond works, in France, steel containing both nickel and chromium has given good results. Developments in this direction, however, have been somewhat checked by the advent of hard-faced steel plates, by which it is aimed to stop and break up the steel projectiles before serious penetration takes place.

The introduction of carbon by cementation into the face of the plate with subsequent water-hardening, as proposed by Harvey, and known as the "Harvey process," has, up to the present time, given the best results in this direction. The application of this process, which was developed at the Bethlehem works, with the energetic aid of the Bureau of Ordnance of the U. S. Navy, has now passed its experimental stage for plates of medium thickness, and the Harveyized 12-in. taper plate, representing the side armor of the "Maine" (recently tested at Indian Head), and manufactured by the Bethlehem Iron Co., gave highly satisfactory results and is beyond doubt the most resisting "service" armor plate ever submitted to trial. This plate resisted and broke up a shot which would have penetrated between 19 and 20 ins. of wrought iron.

Marine Shafting and Engine Forgings.

It may be said that in the manufacture of this class of heavy steel forgings it is not yet the usual practice to aim at the highest attainable combination of physical qualities, and that, therefore, there is a wider field for improvement in this direction than in the case of forgings for guns for armor plate.

From this statement, it must not be inferred that the demands of the U. S. Navy specifications, which may now be taken as the standard in this country, are not such as to insure an excellent quality of steel; on the contrary, the conditions of inspection are rigorous, the amount of testing large, and the physical qualities demanded are such as can only be obtained by the use of high grade stock, by ample forging facilities, and by careful manufacture throughout. The present physical requirements for shafting, including cranks, are: Tensile strength not less than 58,000 lbs. per sq. in., and an average elongation of not less than 28% in longitudinal specimens ½ in. diameter and 2 ins. long, cut from full-sized prolongations of forgings. For connecting and piston rods, a somewhat harder steel with a tensile strength of not less than 65,000 lbs. per sq. in., and an elongation of not less than 25% is used. No treatment other than annealing is prescribed, and the elastic limit is not considered as a condition of acceptance. From these requirements it will be seen that a distinctly soft steel is being used, in which the elastic limit often falls to about 27,000 lbs. per sq. in., and averages something over 30,000 lbs. In adopting such soft steel, the practice of the English Admiralty and Merchant Marine has been followed, and in view of the fact that this practice is based upon wide experience, and the use of a very large amount of material, much of which has done excellent service, it has been a wise and conservative course to make no hasty and radical departures from same.

It must indeed be conceded that soft steel presents, in some respects, marked advantages as the standard material for shafts and engine forgings, particularly when the manufacture is intrusted to forges having insufficient facilities and lack of experience in handling the harder classes of steel. In the ingot form and during forging, soft steel can bear with safety rougher treatment than harder steels; it is less sensitive to the hurtful effects of irregular and repeated heatings, and dangerous internal strains and defects are less apt to be developed thereby; these are important considerations, especially in the case of forgings of irregular shape, such as solid forged cranks, connecting rods, etc. Further, by the use of soft steel, the cost of machining, and hence the cost of finished forgings, is reduced to a minimum. It is natural, therefore, that marine engineers should hesitate to make a change in a matter of such importance, feeling, as they do, that in soft steel forgings there is an element of safety that cannot be overlooked.

In calculating the dimensions of marine engine forgings, the elastic limit of the material used has not been as important a factor as in the designing of heavy guns; this is principally due to the larger factor of safety used in engine forgings to insure stiffness or rigidity of parts under transverse strains. There is much evidence at hand, however, to indicate that the importance of a high elastic limit in steel forgings has not been sufficiently considered and that many failures of soft steel forgings of excellent quality can be ascribed to a low elastic limit. A notable instance is that of locomotive crank-pin forgings, where soft steel has in many cases failed by breakage as frequently as wrought iron, and where a harder steel with higher elastic limit has given far better results. The length of service of hammer piston rods has also been much increased by the use of steel of high elastic limit. These are instances of machine parts subjected to exceptionally severe working strains.

In the highest development of the modern marine engine, reduction of weight of all parts is of prime importance. This can only be accomplished by reducing sectional areas. On the other hand, outside dimensions cannot be usually reduced without sacrificing necessary stiffness. We are, therefore, led to removing the metal along the neutral axes; or, in other words, to the use of hollow forgings. This practice has been followed in designing the shafting of all the ships of the new navy, except the four Roach ships.

In most cases, however, the danger of too great a reduction of sectional area has evidently been feared, and the diameters of axial holes have been made too small to allow of advantageous hollow forging on a mandril. Solid forging, with subsequent boring, has, therefore, been necessary, whereby a distinct loss in quality of metal has occurred.

It is evident that to reduce further relative weights as well as to increase the absolute strength of parts, the designer of marine engines needs a stronger material than that now employed; that is, a material having a greater elastic limit, but at the same time possessing such a degree of toughness as to insure resistance to sudden strain or shock. Such a material can be found in steel harder than that now used, strengthened and toughened by tempering and annealing. Simple steel of the proper natural hardness, and so treated, will show in specimens cut from the center of sections, say, 3 ins. to 6 ins. thick, an elastic limit of about 45,000 lbs. per sq. in., an elongation of about 23% in 2 ins., and a contraction of area of from 50 to 55%. To allow of safe and effective tempering, forgings must be made hollow wherever possible, rectangular sections reduced in thickness as far as practicable, large fillets used, and sharp re-entering angles, and sudden changes from thin to thick sections avoided. In shafting, axial holes should be made large enough wherever practicable to allow of hollow forging, and additional strength with the same weight obtained by increasing both outside and inside diameters, and thus reducing thickness of walls.

Comparison of Three Designs for Steel Steamship Shafts.

	Propeller Shaft U S. S. "Brooklyn."			Int. Line Shaft U. S. S. "Iowa."		
	Hollow shaft. Outs. diam. 17 ins. Ins. diam. 11 ins. Nickel-steel, E. L. 50,000 lbs. per sq. in.	Solid shaft, same (approximate) sectional area. Diam. 13 ins. Simple steel, E. L. 30,000 lbs. per sq. in.	Solid shaft of same strength under applied loads or horse-powers. Diam. 18.90 ins. Simple steel, E. L. 30,000 lbs. per sq. in.	Hollow shaft. Outs. diam. 15¾ ins. Ins diam. 9¾ ins. Nickel-steel, E. L. 50,000 lbs. per sq. in.	Solid shaft, same (approximate) sectional area. Diam. 12⅜ ins. Simple steel, E. L. 30,000 lbs. per sq. in.	Solid shaft of same strength under applied loads or horse-powers. Diam. 17.71 ins. Simple steel, E L. 30,000 lbs. per sq. in.
Areas of sections, sq. ins.	131.95	132.73	280.55	120.17	120.28	246.34
Weights per yd., lbs.	1,346	1,354	2,861	1,225	1,227	2,513
Comparative strengths under applied loads in flexure, or under applied horse powers in torsion	307	100	307	293	100	293
Load at middle of a span of 12 ft., on two supports which strains to ½ elastic limit, lbs.	276.200	89,900	276,200	227,200	77,500	227,200
Length of beam on two supports, which is strained by its own weight to ½ elastic limit, ft.	121.5	77.5	83⅝	115 5	75.75	80⅜
Horse-powers transmitted at 50 revolutions per minute when strained to ½ elastic limit	15,780	5,130	15,780	12,980	4,430	12,980

A further and very pronounced improvement in strength and toughness can be obtained, as already indicated, by the use of nickel-steel, tempered and annealed and prepared for treatment as above described. The use of nickel allows a reduction of carbon, makes the steel more sensitive to temper, and facilitates the tempering of irregular shapes. Specimens from nickel-steel forgings, tempered and annealed, will show uniformly an elastic limit of from 50,000 to 55,000 lbs. per sq. in., an elongation of 23% and above, in specimens 2 ins. long and ½ in. in diameter, and a contraction of area of from 55 to 60%. In cases where, owing to thickness of section and irregular shape, tempering is not advisable, nickel-steel will still show a higher combination of elasticity and toughness than any other material known, under the same conditions. Here, then, is a material admirably suited to the shafting and engine forgings required by the marine engineer in the construction of modern high service engines, and it is believed that as its merits become known, its use will be widely extended.

The Bureau of Steam Engineering has already taken this material into consideration, and in designing the shafting of the "Brooklyn" and "Iowa," it was decided to make the two propeller shafts of the former and the two intermediate line shafts of the latter ship of nickel-steel. The diameters of the "Brooklyn's" propeller shafts will be 17 ins. outside and 11 ins. inside, giving walls 3 ins. thick, while the line shafts of the "Iowa" will be 15¾ ins. outside diameter. and 9¾ ins. inside diameter, with walls also 3 ins. thick. The specifications prescribe that these shafts shall be oil tempered, and demand a tensile strength of not less than 85,000 lbs. per sq. in., an elastic limit of not less than 50,000 lbs., an average elongation of 23% in specimens 2 ins. long and ½ in. diameter (no specimen to fall below 20%).

A comparison of the strength of these shafts within their elastic limit with that of solid shafts of same sectional area made of soft, simple steel, having an elastic limit of 30,000 lbs. per sq. in., and also a comparison of their weights per linear unit with that of soft steel, solid shafts of equal strength may be of interest. The accompanying table gives results of calculations made by Prof. Mansfield Merriman, of Lehigh University. It will be seen that by the use of the hollow shafts made of the stronger steel there is a gain in strength of 3 to 1, and a reduction in weight of more than one-half as compared with solid soft steel shafts of equal weight and equal strength, respectively.

It must be borne in mind that this gain in strength and reduction of weight is not obtained at a dangerous sacrifice of toughness, for the stronger tempered steel is also extremely tough, as shown by cold bending and by the extension and the contraction of area of tensile specimens. It will be readily admitted that such gains cannot be overlooked by the marine engineers, and that there is here a wide field open for improvement in marine engine forgings.

(In illustration of the remarkable gain effected by this use of nickel-steel, the author exhibited a specimen 2½ ins. square cut from a nickel-steel forging, which was so tough that it bent down flat in a cold-bending test without cracking. Yet its elastic limit was higher than the ultimate tensile strength of the soft steel ordinarily used for steel forgings.—Ed.)

ERRATA IN FIELDBOOKS.

A correspondent sends us the following to be added to the list of errata published in our issue of Oct. 26; Searles, log. tan. 65° 15′ should be 10.336293 instead of 10.366293; Johnston's Surveying, nat. cot. 8° 07′ should be 7.01174 instead of 6.91174; a reversal of 9 by 6 in A. Winslow's table for stadia reduction published by the U. S. Geological Survey in either 8° 07′ or 7° 06′, our correspondent is not sure which, not having the table at hand to refer to.

AN ENGLISH LOCOMOTIVE WITH BAR FRAMES.

The adoption of American features of locomotive practice by English builders, particularly in engines for colonial and light railway service, has been several times alluded to in our columns, and we find in a recent number of our London contemporary, the "Engineer," the drawings of a light engine in which the builders have actually gone so far as to use a bar frame. The engine is a small four-wheel engine, 2-ft. gage, with a wheel base of 3 ft., suitable for plantation or industrial railways, and has bar frames, outside cylinders 6 × 9 ins., a saddle tank and a balloon stack with deflector and wire netting at the top. The plate springs are not equalized. The boiler has 32 tubes 1¾ ins. diameter and 4 ft. 5⅞ ins. long. The firebox is of circular form riveted to an exterior flange pressed out of the front plate of the shell. The grate area is 3.28 sq. ft.; total heating surface, 73.77 sq. ft. (tubes 64 sq. ft.); boiler pressure, 140 lbs. The engine carries 104 gallons of water and has a coal space of 4.8 cu. ft. capacity. The "Engineer" says that these engines are made to meet the demand for small engines for various industrial and country railway work, and ought to find favor wherever small locomotives could be used to advantage. Its further comments are as follows:

> For light and cheap locomotives the continental and American makers have for some time taken a large proportion of the orders for various reasons, one of them being that the English makers have not seen their way to change from the solid or miniature main line design. Without in any way scamping work, lessening wearing surfaces, or contracting heating surface, Messrs. W. G. Bagnall claim that they have designed an engine that should compete against the prices of any maker of repute, while offering a better job and without detracting from the good name that the English hold for locomotive work. The chief features are: The bar frame and outside gear, with easy facilities for cleaning and getting at parts; the circular and raised firebox for steam space; large wearing surfaces and grate area, combined with lightness and cheapness. Facilities for repair have been carefully considered. For instance, by taking one row of rivets out, a new firebox can be fitted, and all parts are made to gage and template.

INVESTIGATION OF ROAD CONSTRUCTION AND MAINTENANCE.

In March, 1893, an act was passed by Congress making a special appropriation for an investigation into the road laws and practice of the United States and into the best methods of road construction, maintenance and management. This investigation is to be under the Department of Agriculture, and the Secretary of Agriculture has recently appointed Gen. Roy Stone, President of the National League for Good Roads, as special agent and engineer in charge of this investigation. The following circular has been widely distributed, and much valuable information is expected to be obtained, which will be published by the Department:

> The Department of Agriculture, being charged by Congress with an inquiry into the systems of road management and the best methods of road construction throughout the United States, desires information upon the following points:
>
> 1. The practical working of the recent road laws of the various states wherever the same have been tested, the difficulties found in their application, and suggestions for their amendment.
> 2. The character and cost of the roads built under these laws, the materials used and the present condition and prospective durability of such roads.
> 3. The location and character of any superior stone for roads which is accessible by railway or water, the cost of quarrying, preparing and loading the same, the mileage rates of transportation and any instances of reduced or free transportation given by railways for the encouragement of road building.
> 4. The same information, so far as applicable, regarding materials naturally prepared, such as the Paducah and Tishomingo gravels, the Hamilton sandstones and the Chickamauga flints.
> 5. The results of any experiments in the construction of narrow and cheap hard roads, or of roads having one track of earth and one of stone or gravel, with full particulars as to cost and method of construction.
> 6. The result of any practical experience in the use of burnt clay for roads.
> 7. The cost and benefits of tile drainage of roads as shown by practice.
> 8. The best method of constructing a common highway without gravel or stone, and with or without under-drainage.
> 9. Definite facts as to the enhancement of property values through road improvement.
> 10. The results of any experiments in the employment of convict labor on roads or the preparation of road materials.
> 11. The details of all bond issues for road improvement and how, where and at what cost the same were marketed.
> 12. The rates allowed in each state for men and teams in working out road taxes, and the actual value of such work as compared with labor paid for in cash.
>
> All communications should be addressed to the Office of Road Inquiry, U. S. Department of Agriculture, Washington, D. C.

The new 12,000,000-gallon Gaskill high-duty pumping engine erected by the Holly Manufacturing Co. for the water-works of Port Huron, Mich., was tested Oct. 10 to 12. The results obtained are summarized as follows:

Duration of test	48 hours
Total revolutions	57,653
Average revolutions per minute	20.01
Average piston speed per minute, ft.	126.77
Average steam pressure by gage, lbs.	70.70
Average vacuum, by gage, ins.	26.79
Average total water pressure, lbs.	57.51
Total quantity of water pumped, gallons	24,721,029
Duty of engine, per 1,000 lbs. of steam, ft.-lbs.	125,777,598

The engine is of the horizontal, rotative type, with two 25-in. high-pressure and two 50-in. low-pressure steam cylinders and two 29-in. double-acting pumps, all having 38-in. stroke. We are informed that the guaranties of the contractors were exceeded in every particular, and that the performance of the engine was very satisfactory to all concerned. The city was represented during the test by Mr. Wm. H. Avery, Chief Engineer of the Water Department, and by Mr. J. H. Fitzgerald.

A Georgia road congress meets in Augusta on Nov. 28, this being "Road Congress Day" at the Augusta Exposition.

The interlocking of switches and signals on English railways is steadily increasing toward the hundred per cent. mark, and the Board of Trade return for the year ending Dec. 31, 1892, shows that 98% of them are now interlocked. The figures for 1891 and 1892 are as follows:

	1891.	1892.
England and Wales	97%	98%
Scotland	88%	93%
Ireland	68%	90%
Total, United Kingdom	94%	97%

The return also gives an interesting summary in regard to railway connections and crossings, etc., showing the extent to which they are protected, and under the compulsory powers now possessed by the board the number of cases in which the requirements have not yet been complied with will probably decrease very rapidly. The action of the board in enforcing its powers to compel the adoption of the block system on small lines with light traffic and low finances is being rather sharply criticised by some of the English papers. The summary referred to is as follows:

	No. of cases in which any pass. line is connected with or crossed on the level by any				No. of cases in which the usual requirements of the board have or have not been complied with.					
					Concentration of switch and signal levers.		Interlocking of switch and signal levers.		Addition of safety points in case of goods lines and sidings.	
	Other pass. line.	Goods line.	Siding.	Cross-over.	Have.	Have not.	Have.	Have not.	Have.	Have not.
England & Wales.	4,819	1,947	18,876	7,664	32,486	850	32,630	706	20,217	606
Scotland	970	257	3,394	1,225	5,419	427	5,412	434	3,366	285
Ireland	496	90	1,327	261	1,924	250	1,958	216	1,246	171
Total, Un. King.	6,315	2,294	23,597	9,150	39,829	1,527	40,000	1,356	24,829	1,062

A rapid transit agreement has just been made between the Cincinnati Board of Administration and the Cincinnati Street Ry. Co., which permits the company to extend its lines and to change from horse to electric propulsion on a number of streets. In return for the privileges granted the company is to pay to the city 5% of its gross earnings and an annual car license of $4 per lin. ft., inside measurement, on every car regularly operated. In addition provision is made for a very complete system of transfer and a uniform fare of five cents. The duration of the franchises for existing electric lines is not extended; but for horse lines there is virtually an extension of from 7 to 15 years. The company was already paying 2½% of its revenue from some of its lines to the city. The Board of Administration made a lengthy report in this connection, setting forth the situation and giving the rates of fare charged by railway companies in a number of large and small cities, stating whether the companies give transfers or not and what compensation, if any, they pay to the city for their franchises. A car license of from $10 to $60 a car is quite common, while New York City, Newark, Baltimore, New Orlenas, St. Louis and Buffalo receive a percentage of the revenue of some or all the companies and other cities a lump sum per year. New Orleans recently extended by 50 years a franchise having 13 years to run, at the same time granting the right to use electricity. The extended franchise was sold to the highest bidder for $700,000. The full report is given in the Cincinnati "Commercial Gazette" for Nov. 19, 1893.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

PATH VALLEY.—Grading on this road was commenced at Dry Run, Pa., last week. The line now building is from Germantown to Dry Run, about 16 miles, and surveys are being made for an extension from Dry Run to Fannettsburg, a distance of eight miles. Pres., David Gring, Newport, Pa.

WABASH.—Press reports state that an extension will probably be built within a year between Fort Wayne on the main line and Butler on the Detroit division, a distance of about 35 miles. The company owns its own track from Butler to Detroit, but from Butler to Logansport, 93 miles, it leases the old Eel River road, the possession of which, under the lease, is now being disputed in the courts. It is argued that two or three years' rental of the Eel River at $90,000 per year would build the cut-off to Butler and afford the same connection with the Toledo-St. Louis main line. The main shop of the eastern division being located at Fort Wayne it would greatly facilitate getting equipment of the Detroit-Chicago road division back and forth from the shop.

WILLIAMS VALLEY.—It is reported that work will be commenced early next year on an extension from Williamstown to Millersburg, Pa., by way of Berrysburg, a distance of about 19 miles.

Projects and Surveys.

BERWIND-WHITE COAL CO.—This company is said to be making surveys for a railway from South Fork, Pa., into the territory along Stony Creek, in Cambria county.

INDIANAPOLIS, LOGANSPORT & CHICAGO.—This company was incorporated in 1891 to build a railway from Indianapolis through Logansport to Chicago. The line has been surveyed between Indianapolis and Logansport, 70.6 miles, and about 60 miles of the right of way secured. The construction has been delayed by the stringency of the money market, but it is reported probable that work on the line will soon be commenced. Pres., Edward N. Talbott, Logansport, Ind.

LACKAWANNA, CATSKILL MOUNTAIN & BOSTON.—The projectors of this road are reported to have abandoned the idea of a line from Deposit, Pa., to Schenectady, N. Y., as originally planned, and now propose a road from Deposit to Albany, N. Y., and across the Albany and Greenbush bridge to the East. From Lebanon Springs two branches are proposed, one running to Northampton, Mass., and the other to North Adams, Mass. The proposed branch to Troy will connect with the main line at Greenbush. J. W. Van Valkenburgh, Albany, president of the projected New York, Boston, Albany & Schenectady R. R., is interested in this company. He is reported as stating that the capitalists behind the project are coal men, who have united to fight the railway companies, and will build the road in order to get their coal to market. The company was incorporated last January with a capital stock of $2,000,000 and the first line proposed was surveyed by Wm. Gifford, Schenectady.

Southern—Existing Roads.

GEORGIA SOUTHERN & FLORIDA.—A press dispatch from Macon, Ga., states that this road is to be sold on the first Tuesday in March, 1894. The minimum price that will be received as a bid is $3,500,000. The bonded debt amounts altogether to $3,800,000. It is thought probable that the road will be purchased by the bondholders, and it is said that the Seaboard Air Line will eventually become the owners of the line. The road extends from Macon, Ga., to Palatka, Fla., a distance of 285 miles.

Projects and Surveys.

POWELL'S MOUNTAIN MINERAL.—Efforts are being made to secure the early construction of this railway, which was recently chartered at Nashville, Tenn. The road will be about 60 miles long and will form a connection, according to reports, between the Knoxville, Cumberland Gap & Louisville and South Atlantic & Ohio roads. L. M. Jones, H. F. Coleman and A. J. Tyler are among the incorporators.

ROANOKE RY. CONSTRUCTION CO.—Incorporated at Roanoke, Va., to build a railway to bring the Chesapeake & Ohio and Baltimore & Ohio roads to that city. Pres., Robt. H. Woodrum, Roanoke; Vice-Pres., J. Fred. Effinger, Staunton; Secy. and Treas., J. W. Coon, Roanoke.

SANDERSVILLE.—John N. Gilmore, Sandersville, Ga., is interested in a proposed railway between that place and Tennille, Ga., a distance of three miles.

Northwest—Existing Roads.

DULUTH & IRON RANGE.—The Virginia, Minn., "Enterprise" states that this company contemplates a considerable amount of new work in that vicinity the coming winter and that condemnation proceedings for right of way around Virginia Lake have already been commenced. Another scheme also reported as taking on a hue of probability is that of building an air line from the mouth of Knife River to Virginia, entering the city to the west of Silver Lake and connecting with the loop to the north of Virginia Lake and extending west along the range.——An extension is being built from Ely, Minn., north four miles to sawmills of the Knox Lumber Co.

DULUTH & WINNIPEG.—It is reported that the contract has been awarded for an extension of this road to the Diamond mine, on the west Mesabi range in Minnesota; also that the road will be built to the Mesabi Chief mine and the village of Hibbing. This is probably the same project as noted in our issue of Nov. 2 under Minnesota & Mesabi.

DULUTH, MESABI & NORTHERN.—Press reports state that Leonidas Merritt, Vice-Pres., is now in New York making financial arrangements for double-tracking this road, the work to be commenced at once. There will be very little rock work, and therefore the undertaking will not be a very serious one. The plan as outlined at present is to start the double track from the top of Duluth Hill and run it to Iron Junction. It is calculated that the saving in the number of cars that can be expeditiously moved will fully compensate for the cost of the double track in a very short time. From Iron Junction the branch lines to the different mines will not require double tracks for some time.

DULUTH TRANSFER.—It is stated that this company will build 24 miles of extensions next year. About six miles of track have been laid at Duluth this year and about four more are expected to be completed by Jan. 1. Pres., D. K. Smith, Duluth, Minn.

Southwest—Existing Roads.

KANSAS CITY, PITTSBURG & GULF.—The city council of Pittsburg, Kan., is reported to have settled the controversy over an issue of bonds to aid this road and the bonds will soon be issued. The company's shops will be located at that place.

Rocky Mt. and Pacific—Existing Roads.

GREAT SALT LAKE & HOT SPRINGS.—It is expected to complete the extension of this railway from Bountiful, nine miles from Salt Lake City, as far as Centreville, Utah, a distance of six miles, this fall. The line is projected to Coalville, 52 miles. Ch. Engr., H. S. Joseph, Salt Lake City, Utah.

SANTA FE, PRESCOTT & PHOENIX.—About 200 men are now at work on this railway between Prescott and Phoenix, Ariz. The line extends from Ash to Prescott and thence to Phoenix, a total distance of 196 miles, and has been completed for several months as far as Prescott. Ch. Engr., G. W. Vaughn, Prescott, Ariz.

VICTORIA & SIDNEY.—Tracklaying has been commenced on this road between Victoria and Sidney, B. C., a distance of 11 miles. Contractor, Thos. W. Paterson, Victoria, B. C.

Foreign.

MEXICO.—Press reports from Guadalajara, Mex., state as follows: There are a number of important railway projects being organized in this part of Mexico, and it is only a question of a few years when all of the Pacific Coast ports of Mexico will have railway connection with Central and Northern Mexico. The organization of the company to build a railway from this city to Chamela has been completed and construction will be commenced at once.——It is reported that Francis H. Woodhouse, of England, has obtained a concession for constructing a railway from a point on the Mexican (Vera Cruz) Ry., between the stations of Guadalajara and Apizaco, to the iron works to be established in the municipality of Zacatlan.

TEHUANTEPEC.—A dispatch to the St. Louis "Globe-Democrat" states that a number of trains of workmen and construction outfits left the city of Mexico Nov. 14 for the Isthmus of Tehuantepec to resume the work of building the Tehuantepec R. R. after a cessation of several months on account of financial difficulties. The new contracts have been let by Chandos Stanhope. There is a gap of about 60 kilometers yet to be constructed. Every possible means will be taken to complete this by the month of May, before the rainy season sets in.

STREET RAILWAYS.

LEWISTON JUNCTION, ME.—Work on the electric railway to Poland Springs, a distance of 3½ miles, has been commenced by Geo. S. Staples, Portland.

MANCHESTER, N. H.—The board of trade has pledged support to the scheme for an electric railway between this city and Haverhill, Mass.

ABINGTON, MASS.—The directors of the Abington & Rockland Electric Ry. have agreed to construct a branch to Assinippi, a suburb of Rockland, according to reports.

CONWAY, MASS.—Chas. Batchelder, Franklin Pease and others have petitioned for a charter for the Conway Electric St. Ry. Co.; capital stock, $50,000.

NORTHAMPTON, MASS.—The Northampton Electric Ry. Co. has begun a preliminary survey for an extension of its line up the Mill River valley as far as Wiliamsburg, which is the terminus of the Williamsburg branch of the New York, New Haven & Hartford R. R. The road will run through the villages of Leeds and Haydenville, the whole distance being about eight miles. The work of construction is expected to begin early in the spring.

NEW BRITAIN, CONN.—There is talk of extending the electric railway through Newington to Hartford.

BROOKLYN, N. Y.—The Brooklyn, Bergen Beach & Canarsie R. R. Co. has been incorporated to construct about 19 miles of electric railway; capital stock, $200,000; Thos. Adams, Jr., L. R. Adams, Brooklyn; P. G. Williams, New York; H. E. Hughes, C. E. Morrell, F. W. Lemken, Canarsie; D. I. Wright, Alex. Stafford, Flatlands.

BROOKLYN, N. Y.—The People's R. R. Co. has been incorporated and has petitioned for franchises. The company has a capital of $325,000 and proposes to construct an electric railway about 32 miles in length in this city, Flatbush, Flatlands and New Utretcht. The directors are: Francis J. Callanen, Rutherford, N. J.; J. S. Fargotston, L. G. Fargotston, M. J. Kelly, E. W. Nelson and Horace Moody, New York; C. M. Nichols and Frank Gardner, Brooklyn; Stephen Parrish, Jersey City.

WHITESTONE, N. Y.—The Whitestone & College Point Ry. Co. has been incorporated to build about six miles of street railway; capital stock, $60,000; I. J. Merritt, Jr., Moses Worms and others, Whitestone; J. F. Anderson, Bayside; H. D. Low, Mount Vernon; W. C. Foster, Long Island City; J. J. Delaney, College Point.

CHESTER, PA.—A press report states that if the plans now projected can be carried into effect, this city will be the center of an extensive electric railway system in the course of a year. The trolley line between Philadelphia and Chester is nearly completed, and application has been made for the use of the turnpike in order to extend the railway to Wilmington next spring. The company has arranged terms with the Union Ry. Co., of Chester, and will use the latter's tracks through the city. A charter has been secured for another line between Philadelphia and Chester; the route to be along the Delaware River on what is popularly termed the Island Road. The right of way has been granted to the People's Ry. Co., which will build a line between Chester and Rockdale next spring, ultimately extending this to West Chester. This railway will connect at the city line with the Island Road Trolley Ry. A charter has also been secured by the Chester, Media & Middletown Ry. Co., a syndicate that desires to build a road from this city to Media, as a rival to the Union Ry. Co.

POTTSVILLE, PA.—The Anthracite Electric Ry. Co. has been formed to construct and operate an electric railway; capital stock, $500,000; J. Newlin, E. S. Newell, L. B. Walker.

BELAIR, MD.—The Deer Creek Ry. Co. will now push the proposed electric road between this city and Havre de Grace. The right of way has about all been secured.

BOONSBORO, MD.—Work on the electric railway to Keedysville was commenced Nov 17 by Degriat & Levering, Philadelphia, who were awarded the grading contracts by the Hughes & Rigby Engineering Co. The line will be laid with 85-lb. steel rails.

LYNCHBURG, VA.—The contracts for building an extension of the Rivermont St. Ry. to the Presbyterian cemetery has been awarded to Pepper & Register, Philadelphia, the work to be commenced as soon as possible.

CINCINNATI, O.—The Cincinnati Street Ry. Co. has been granted franchises for extending five of its routes. In addition to the extensions proposed the work includes the changing of the motive power of some six horse car lines to electric power. A liberal system of transfers is provided for and the city is to receive 5% on the gross earnings of the extensions and a car license of $4 per lin. ft. per year, estimated at not less than $80,000 for the first year. These franchises have been under consideration for several months, and the result is considered as a victory for rapid transit.

LANSING, MICH.—The Lansing City R. R. Co. is reported to have executed a chattel mortgage for $160,000 on its property to secure money for extensions.

DUNDEE, ILL.—The Dundee Rapid Transit Co. has been incorporated; capital stock, $50,000; E. C. Hawley, G. F. Oatman, Wm. Fay. It is proposed to build an electric railway to Aurora, as stated in our issue of Nov. 2.

HAMILTON, ONT.—It is reported that John N. Lake has completed the preliminary arrangements for building the projected incline railway, and that the road will be built in the spring.

TOKIO, JAPAN.—Press reports from Spokane, Wash., state that J. W. Goss and Engineer Riblet have started for this city as representatives of American capitalists who propose to construct an electric railway from this city to Yokohama, a distance of 30 miles, with a complete system of lines in each of the two cities. Rev. J. M. Law secured the charter, which is said to be the most liberal ever granted by the Emperor. The company has the choice of right of way and needs build only one mile of road the first year. The entire line need not be completed until 1898.

ELEVATED RAILWAYS.

CHICAGO, ILL.—It is reported probable that the South Side Alley elevated road will soon run a branch to Englewood. A large number of property owners in Englewood, Eggleston and Auburn Park are interested in the matter, and for some time past members of the company are reported to have been looking over the grounds with a view to selecting the route of the proposed extension.

MONTREAL, QUE.—The aldermen have voted to grant a franchise for an elevated electric railway to the Belt Line Co. for an annual tax of $2,000 per mile. The line will extend along St. Catherine St. East down Delorimer Ave., through Craig and St. James Sts. to the western city limits.

HIGHWAYS.

MASSACHUSETTS.—Surveys have been made by Barnes & Burdock, Pittsfield, for a new highway in the town of Lee.——At the second annual hearing of the state commission on highways, held at Northampton, Nov. 17, a petition was considered for a road from Northampton through Williamsburg and Goshen to Cummington. One of the commissioners is reported as stating that the ultimate object is to build in every town in the state one good road through it in its most useful course. It is hoped to build from seven to ten miles of road a year in each county to cost about $500,000 per year and which in 20 years would give the state as good roads as are anywhere in the world.

BRIDGES AND TUNNELS.

UTICA, N. Y.—The contract for an iron bridge over the Erie Canal in Genesee St. has been awarded to the Hilton Bridge Constructing Co., Albany, at $37,450, the other bids being Dean & Westbrook, New York, $44,000; Kellogg Iron Works, Buffalo, $57 230; Berlin Iron Bridge Co., East Berlin, Conn., $58,200.

PHILADELPHIA, PA.—The survey committee of councils has voted to recommend the construction of a bridge, estimated to cost $340,000, in place of the one across the Schuylkill River which was destroyed by the storm last summer. Plans have been prepared for a double-decked bridge, resting on two piers in the river and estimated to cost $700,000. The plans recommended were suggested by the director of public works and provide for the addition of an upper deck whenever deemed necessary. A single-deck bridge not built to provide for an additional deck would cost $225,000.

PITTSBURG, PA.—The Glenwood Highway Bridge Co. has been incorporated by Jas. P. Wilson, Herman Lamb and others to build a bridge to carry the projected Pittsburg & Homestead Electric St. Ry. across the Monongahela River near the junction of the Baltimore & Ohio R. R. and Second St.; capital stock, $5,000. The bridge is estimated to cost $150,000 and will be built in the spring.

FRANKFORT, KY.—The Seckner Contracting Co., Chicago, has been awarded the contract for a 406-ft. span iron bridge over the Kentucky River at this place.

CINCINNATI, O.—Frank Krug, Co. Engr., has reported that it will cost $10,950 to build the culvert over the C., L. & N. R. R. at Kennedy Ave.

CHICAGO, ILL.—It is reported that bids will be asked at once for the proposed Van Buren St. bridge, for the construction of which permission has just been granted.

ST. PAUL, MINN.—Bids are asked until Dec. 1 for the construction of a wagon bridge across Antelope Creek at Fort Yates, N. Dak. John V. Furey, Ch. Q. M., U. S. A.

JEFFERSON CITY, MO.—The citizens of this city want a railway or wagon bridge across the Missouri River to connect Cole and Callaway counties. Over $45,000 has been raised as a bonus to some company willing to construct the bridge, and the commercial club is reported as intending to make this $50.600. For particulars address J. G. Lewis, Secy. Com. Club.

ST. LOUIS, MO.—The question of a bridge over Clark Ave. between 18th and 20th Sts. or of a tunnel has not yet been decided by the board of public improvements. Each is estimated to cost about $150,000, and the one decided upon will probably be constructed as soon as possible.

VELASCO, TEX.—It is reported that the county commissioners have decided to build a bridge across the Brazos River at or near Columbia.

DENVER, COLO.—Bids are asked until Dec. 1 for driving 1,000 ft. on a tunnel near Idaho Springs, contractors to supply machinery for air drills. E. J. Wilcox, 465 South Water St.

TILLAMOOK, ORE.—The Wilson bridge near this city has been washed away by a storm. The bridge had just been completed and accepted by the county.

WINNIPEG, MAN.—The city engineer has reported estimates for three new bridges: Main St., 24-ft. roadway, 6-ft. sidewalk, $54,000; Osborne St., utilizing the present Main St. superstructure, $26,000; Boundary St., utilizing turntable and some of iron of Osborne St. bridge, $35,000. This provides iron superstructure for the Main St. and Osborne St. bridges, and wooden superstructure for the Boundary St. bridge; all bridges to have masonry piers.

WATER-WORKS.

MANCHESTER, N. H.—The following bids were received for the high-service reservoir, the prices including gate chamber connecting 20-in. pipe: Trumball & Ryan, Boston, $32,791; H. E. Fletcher & Co., West Chelmsford, $33,263; Moore & Co., Boston, $36,698; Frank B. Bodwell & Co., Manchester, $37,878; Head & Dowst Co., Manchester, $38,324; W. H. Ward, Lowell, $38,356. The reservoir is mostly in ledge and will have a rubble wall on the inside; earth embankment on the outside and the bottom will be covered with cement concrete. Geo. E. Rice and Geo. E. Evans, Engrs.

SUNCOOK, N. H.—E. Baker and Geo. P. Cofraw are reported as putting in works, the supply to be pumped by a windmill from a well into a tank.

BURLINGTON, VT.—The contract for extending the intake into the lake had been awarded to Jos. G. Falcon, Evanston, Ill., at $47,900, as stated last week. The work includes 11,880 ft. of 24-in. cast iron pipe, weighing 165 lbs. per ft., with a Falcon flexible ball joint for every six lengths of pipe, or a total of 160 joints. At the end of the pipe there will be a strainer designed by F. H. Crandall, Supt. A well 12 ft. in diameter and 24 ft. deep is also to be put in by Mr. Falcon.

LYNDONVILLE, VT.—H. C. Wilson, Vil. Clk., informs us that the village is now waiting until its charter can be changed so as to enable it to own property to the amount of the proposed works.

WEST RUTLAND, VT.—Inman Bros., New York, have been awarded the contract for works to be built in the spring.

BROCKTON, MASS.—The commissioners find that about six miles of new mains would be required for the proposed extensions to Cary Hill and Brockton Heights.

LYNN, MASS.—The council is investigating the question of better service in the Highland district. Plans prepared last year estimate the cost of this improvement at $36,500 to $51,600, according to plan.

QUINCY, MASS.—The council has voted to submit the question of a supply from Blue Hill River to a vote of the citizens.

WORCESTER, MASS.—The council is reported to have appropriated $15,000 for preliminary surveys and the purchase of land for an additional storage reservoir.

WOONSOCKET, R. I.—The council has appropriated $15,000 for a new storage reservoir.

AUBURN, N. Y.—The Auburn Water-Works Co. has offered to sell its plant to the city for $425,000.

BUFFALO, N. Y.—Extensive improvements are being made in the South Buffalo district. About five miles of pipe are yet to be laid in the city and 300 men are now employed by the department.

M'CONNELLSVILLE, N. Y.—The water company has the works about completed. The mains will probably be extended in the spring. A. B. Chrestien, Supt.

NEW BRIGHTON, N. Y.—The stockholders of the Staten Island Water Supply Co. have voted to increase the capital stock to $1,000,000.

NIAGARA FALLS, N. Y.—It is reported that bonds have been issued to pay for laying about two miles of 18-in. mains.

PORT JERVIS, N. Y.—E. F. Mapes, Vil. Clk., informs us that the question of municipal ownership of the works is being discussed, but cannot be decided until next year.

WHITESTONE, N. Y.—The commissioners are considering the purchase of the plant owned by the Central Forge Works, according to reports, at about $7,500.

GLASSBORO, N. J.—The Teichler Water & Light Co. is reported to have stated that if 25 residents of this place and an equal number from both Clayton and Pitman Grove will subscribe $200 in bonds each, the company will put in works to supply these places. Treas., Isaac Moffett, Glassboro.

ALLEGHENY, PA.—The council's sub-committee and Julian M. Kennedy, Engr., went to St. Thomas, Ont., last week to examine the filtration system in use at that place.

ALTOONA, PA.—The following bids were received for the proposed impounding reservoir: Collins & Martin, Bellfonte, $156,503; Brown Bros., Philadelphia, $164,591; W. G. Stahl & Sons, Altoona, $162,500; Malone & Codde, Philadelphia, $158,800. C. A. Martin, Secy.

CATAWISSA, PA.—The "News" states that Judge Sherman has a scheme for works and an electric light plant in this place.

NEW CASTLE, PA.—The Consumers Water Co. has been incorporated by G. D. Moyer, F. H. Cheyney and Jacob Stone, Philadelphia; capital stock, $30,000.

PATTON, PA.—The Patton Water Co. has been incorporated; capital stock, $18,000.

PHILADELPHIA, PA.—The committee has decided to ask for $4,220,564 for next year, including $2,935,000 for extensions.

READING, PA.—The council has granted an additional appropriation of $19,000 to the water department.

LAUREL, MD.—The citizens are trying to secure works for fire protection.

WASHINGTON, D. C.—Capt. Geo. McC. Derby, Asst. to Engr. Comr., has reported that the proposed high-service system will cost about $600,000, and that it has been decided to spend the $205,470 now available in constructing a reservoir at Fort Reno, installing a new pump at the U St. station and laying additional mains. An appropriation of $102,691 to raise the dam at Great Falls and secure an increased supply is also recommended.

ATLANTA, GA.—The report noted last week is stated by Geo. W. Terry, Jr., Secy., to be incorrect.

GRIFFIN, GA.—An election will be held Dec. 6 to vote on an issue of bonds for $16,000 for works and electric lights.

NEW ORLEANS, LA.—Bids are asked until Nov. 27 for laying mains in several streets. L. H. Gardner, Supt. New Orleans W.-Wks. Co.

BRILLIANT, O.—W. C. Smith, Tn. Clk., writes us that the proposition to issue bonds was defeated.

CADIZ, O.—It is proposed to begin the construction of works in the spring. Bonds for $35,000 have been voted, as stated in our issue of Nov. 9.

CINCINNATI, O.—The estimates for next year include the following: Main pipe extension, $100,000; Price Hill tank house and foundations, $40,000; Cumminsville reservoir, $10,000; Fairmont supply, $25,000; completion of Eden Park pumping station, $20,000; rebuilding No. 5 and erecting No. 7 and No. 8 engines, $12,000; completion of 36-in. force main for pumping station at Eden Park reservoir, $30,000.

ALEXANDRIA, IND.—A Chicago company has presented plans for works, but the council is reported as undecided whether to award a franchise or to construct municipal works.

GALESBURG, MICH.—The Galesburg Water Supply Co. has been granted the privilege of laying pipe in several streets for fire protection.

ARROWSMITH, ILL.—R. S. Krum will purchase a windmill and put in works, according to reports, the supply to be from a well 120 ft. deep.

CENTRALIA, ILL.—The council has engaged Hiram Phillips, St. Louis, to prepare plans for city works, and it is expected that bids will soon be asked for the construction.

GROSSDALE, ILL.—The residents of this village and Hollywood have voted to unite in a village corporation, and it is proposed to issue bonds for works and other improvements.

KANKAKEE, ILL.—Extensive improvements and additions are to be made to the water supply of the Illinois Hospital for the Insane. E. M. Nichols, Ch. Engr.

MARENGO, ILL.—The contract for works and an electric light plant has been awarded to the Seckner Constructing Co., Chicago, at $38,784.

OTTAWA, ILL.—Bids will probably be opened this fall for new works estimated to cost $178,000, the supply to be from wells. Geo. C. Morgan, Engr., Chicago; Jason F. Richardson, Jr., Cy. Clk.

SOUTH MILWAUKEE, WIS.—The contracts for valves for the new works has been awarded to the Rensselaer Valve Co., through O. Jones, Monadnock Block, Chicago. A statement of the other awards was published in our issue of Nov. 2 under Contract Prices.

DULUTH, MINN.—Plans have been prepared for new works which the city engineer is reported as stating are not intended to parallel or duplicate the Duluth Gas & Water Co.'s mains. The construction seems to depend upon the sale of $800,000 of bonds voted in 1891.

MANKATO, MINN.—The council will receive bids until Nov. 25 for a 1,500,000-gallon compound non-condensing pumping engine.

HOT SPRINGS, S. DAK.—It is reported that the Water, Light & Power Co. has secured franchises which will result in an expenditure of about $25,000 in the city this winter.

MITCHELL, S. DAK.—The city will sink another well and may erect a stand-pipe. F. P. Stearns, Cy. Aud.

CLINTON, MO.—The Home Water-Works Co., which bought the plant of the Clinton Water Co. last July, will erect a new stand-pipe and make improvements to cost about $25,000. W. A. Foote, Secy.

DARDANELLE, ARK.—It is reported that works will be put in.

TRINITY, TEX.—An effort is being made to build a reservoir to secure a supply for residents of the village and for railway purposes, according to reports.

GLOBEVILLE, COLO.—Mayor Clark and Martin Camps are members of a committee to investigate the question of works. The American Water Co. has offered to furnish a supply at 5½cts. per 1,000 gallons.

SPRINGER, N. MEX.—The works have been purchased by P. P. Talle, N. M. Salazar and others, and will be thoroughly repaired, according to reports.

GARFIELD, WASH.—It is reported that work has been commenced on a new contract which contemplates the completion of the works.

OAKLAND, ORE.—The contract for the reservoir for the proposed works has been awarded to U. G. Hayne, Albany. As soon as bonds have been sold contracts will be awarded for the remaining work, including 5,280 ft. 6-in. pipe, 5,900 ft. 4-in. pipe, 1,390 ft. 3-in. pipe and 22 hydrants; pressure, 75 to 115 lbs., with no dead ends in pipe line. The supply will be from the Calajooia River; estimated cost of works, $11,000. J. G. Kelly, Engr., Eugene R. L. Stephens, Cy. Clk.

SAN FRANCISCO, CAL.—The Citizens' Water Co. has been incorporated by C. N. Felton, J. S. Fry, C. D. Wright, J. M. Morehead and E. G. Wheeler; capital stock, $1,000,000.

AYLMER, QUE.—The taxpayers have voted in favor of the water-works bylaw.

COATICOOK, QUE.—The present supply has been condemned by the medical health officer.

AYLMER, ONT.—It is probable that the source of supply will be changed next year to a number of springs furnishing 1,500,000 gallons per day. This work would require about 1½ miles of 15-in. pipe and the building of a reservoir. Alex. Milne, Engr. and Supt.

LONDON, ONT.—The commissioners have decided that a new pumping engine and another main are necessary. The main is estimated to cost $78,000.

IRRIGATION.

GLENWOOD SPRINGS, COLO.—The Grass Valley Orchard Co. is reported as preparing to enlarge its irrigation ditch.

AMARGO, N. MEX.—The Kutz Land and Improvement Co. has been incorporated to take water from the Navajo River in Colorado to irrigate the Amargo Valley in Rio Arriba county, N. Mex. Pres., Geo. W. Kutz; Treas., H. S. Votaw.

SEWERS.

SPRINGFIELD, MASS.—C. M. Slocum, Cy. Engr., writes us that the city is building a 24 × 36-in. brick sewer in the village of Indian Orchard, the work being done by the city sewer department.

ROCKVILLE, CONN.—The special committee has recommended a system of sewage disposal by filtration, the estimated cost of the system complete being $75,000 to $125,000. The question will probably be considered at the annual city meeting, Dec. 4.

NEW ROCHELLE, N. Y.—Bids are asked until Nov. 27 for a sewer in tunnel under the railway tracks. J. Q. Underhill, Pres. Comrs.

SYRACUSE, N. Y.—The council has authorized the advertising of bids for 15 and 18-in. tile sewers.——The following bids were opened Nov. 13 for brick and tile sewers in several streets: Thos. Marnell, $22,997; L. D. Hulbert, $23,617; Fred La Strange, $24 940; Matthew Dillon, $30,124; Wm. G. Cook, $24,956; J. W. Bustin, $23,044; E. S. Candee, $27,974.

CAMDEN, N. J.—The Pennsylvania Sanitary Sewerage Co. has been incorporated; capital stock, $50,000.

JERSEY CITY, N. J.—Bids are asked until Nov. 27 for main sewers. E. A. Dugan, Chn. Com.

PATERSON, N.J.—The board of health has recommended that sewers be constructed in the New Holland district and also to provide means of relief for the Sandy Hill system.

LEBANON, PA.—Bids are asked until Nov. 29 for a sewer or culvert in South Tenth St. Jos. Krause, Cy. Clk.——The council has engaged T. R. Crowell to make plans for proposed sewers.

SUMMERVILLE, GA.—It is reported that the city will issue bonds for a system.

ST. AUGUSTINE, FLA.—The "News" says that the time has come to spend $40,000 for sewers and $20,000 for streets.

MERIDIAN, MISS.—The city has voted to issue bonds for $100,000 to construct a system, for which plans have been prepared by Samuel M. Gray, Providence. N. M. Brandon, Cy. Engr.

BROOKLYN, O.—Bonds for $11,000 have been sold for a sewer in East Newburg St.

CINCINNATI, O.—The board of administration will receive bids until Dec. 13 for a sewer in Badgeley Run, Chase and Virginia Aves. and Kirby Road.

MARIETTA, O.—We are informed that the city will probably contract for about a mile of 6-in. sewer next year.

SANDUSKY, O.—Bids are asked until Dec. 2 for a sewer in Water St. A. W. Miller, Cy. Clk.

SPRINGFIELD, O.—Surveys are being made for an intercepting sewer about five miles long. W. H. Linn, Cy. Engr.

INDIANAPOLIS, IND.—The board of public works has ordered the construction of two main and five local sewers.

PONTIAC, MICH.—An election will be held Nov. 28 to vote on the proposed issue of bonds for $25,000 for sewers.

CHICAGO, ILL.—Contracts for sections A and C of the Wentworth Ave. sewer are reported to have been awarded to Wilson & Jackson, at $282,245 and $111,835, respectively.

OTTAWA, ONT.—Plans have been prepared for new trunk sewers to drain the entire city, the estimated cost being $356,690. It is reported that the question of issuing bonds for the construction will be voted on by the taxpayers in January.

STREETS.

SPRINGFIELD, MASS.—C. M. Slocum, Cy. Engr., informs us that all work is done by the city street department instead of by contract. The city has been engaged during the past season in constructing granite block, vitrified brick and macadam pavements.

BRIDGEPORT, CONN.—The mayor and other city officials visited Baltimore last week to examine the asphalt, asphalt block and brick pavements. The city has been using granite blocks, but objection is made to the noise. The granite quarries are near the city and granite pavement costs about $2.25 per sq. yd. by contract.

BROOKLYN, N. Y.—Bids are asked until Dec. 1 for paving one street with asphalt. John P. Adams, Comr. Cy. Wks.

NIAGARA FALLS, N. Y.—It is reported that about two miles of asphalt or brick paving will probably be constructed next season.

YONKERS, N. Y.—The contracts for paving Hudson St. and Buena Vista Ave. with asphalt have been awarded to the Barber Asphalt Paving Co. at $9,915 and $20,219, respectively. The other bids were as follows: Warren-Scharf Asphalt Paving Co., $10,068 and $20,616; Trinidad Asphalt Paving Co., $10,300 and $21,082; Vulcanite Paving Co., $10,036 and $20,489. The contract for paving South Broadway was also awarded to the Barber Asphalt Paving Co., at $35,797.

CINCINNATI, O.—The board of administration will receive bids until Dec. for paving one street with brick.——The county commissioners have awarded the contracts for paving Columbia Ave. to Chas. Llockenbrink, at $66,157, and that for paving Michigan and Shaw Aves. to Kolthoff & McCarren, at $25,361. In each case a lower bid was rejected as informal.

MARIETTA, O.—J. B. West, Supt. Water-Works, informs us that the city may contract for paving several streets with brick next year.

INDIANAPOLIS, IND.—The board of public works has ordered improvements in four streets and seven alleys.

GRAND RAPIDS, MICH.—The council has decided to issue $100,000 of street improvement bonds and to push several large improvements so as to give work to a large number of unemployed men. This will make $300,000 of these bonds issued this year.

HARVEY, ILL.—C. E. Loss & Co., Pullman Bldg., Chicago, have been awarded contracts for improving three streets, at about $30,000.

KANSAS CITY, MO.—Bids are asked until Nov. 27 for eight contracts. John Donnelly, Cy. Engr.

HOUSTON, TEX.—The board of public works has voted to construct stone, brick, cement and asphalt sidewalks in five wards.

ELECTRIC LIGHT AND POWER.

BRIDGETON, N. J.—The council is reported as considering the advisability of issuing bonds for $100,000 for an electric light plant and a city hall.

RICHMOND, IND.—Bids are asked until Dec. 18 for street lighting. Chas. G. Swain, Cy. Clk.

GROSSE POINT, MICH.—The Grosse Point Water Co. has increased its capital stock and will add an electric light plant, according to reports.

HOLLAND, MICH.—Bonds for $12,000 have been sold and a plant will be put in as soon as possible.

IMLAY CITY, MICH.—The citizens are reported as contemplating putting in a municipal electric light plant.

KALAMAZOO, MICH.—Bids are asked until Dec. 9 for lighting the streets for 3, 5 or 10 years. Chauncey Strong, Cy. Clk.

CARMI, ILL.—Jerome Wallis, Geo. Wust and Chas. Faulkner have been granted a franchise to establish an electric plant. The city contracts for 30 arc lights at $90 per light per year for street lighting and the contractors expect to put the plant in at once.

GROSSDALE, ILL.—The residents of this place and Hollywood have voted unanimously to unite in one municipal corporation. It is proposed to issue bonds for an electric light plant and other improvements.

MASCOUTAH, ILL.—The Mascoutah Electric Light Co. is reported as to issue bonds for $5,000 for a new power house.

HOT SPRINGS, S. DAK.—It is stated that the Water, Light & Power Co. has secured franchises for works upon which about $25,000 will be spent this winter.

SCIO, ORE.—A committee has been appointed to contract for an electric light plant, according to reports.

NEW COMPANIES.—Reed Electric Co., Camden, N. J.; $500,000; G. Stahl, Philadelphia; C. J. Reed, Orange, N. J.; W. A. Robbins, Camden, N. J.——Colebrook Electric Light Co., Colebrook, N. H.; $12,000.——Baltimore Electric Co., Baltimore, Md.; $10,000; R. C. Rhodes, Phoebus Alexander, C. C. Rhodes, C. C. West, F. V. Rhodes.——Marble City Electric Co., Rutland, Vt.; $50,000; J. A. Sheldon, F. M. Butler, H. M. Bates.——Boardman River Electric Light & Power Co., Traverse City, Mich.; $100,000.——Kane Electric Light Co., Kane, Pa.; $15,000; Pres., J. F. Tener, Pittsburg; franchise granted and plant will be put in at once.

CONTRACT PRICES.

SEWERS.—Holyoke, Mass.—The contract for the rubble stonework, cement and concrete required in 2,500 lin. ft. of the Elmwood sewer system has been awarded to G. L. Bosworth & Co., at $4.25 per cu. yd. for stonework and $5 for concrete. Delaney Bros. bid $5.80 for both, and Timothy Mahoney $5 for stone and $6.25 for concrete.

LEVEE WORK.—Vicksburg, Miss.—The Fifth Louisiana Levee Board has awarded the following contracts: Biggs levee, John Scott & Sons, 60,000 cu. yds., 28 cts. per cu. yd; Obrien and Towne levees, raising and enlarging, 30,000 cu. yds., Long & Harris, 9¼ cts.; Pecan Grove levee, 25,000 cu. yds., J. C. Hodge, 14⅞ cts.; Illawara levee, 23,000 cu. yds., M. Irwin, 11.44 cts.; Desonia levee, W. F. Coltharp, 20,000 cu. yds., 14.45 cts.

PUMPING ENGINES.—New York, N. Y.—The following bids have been received for two 10,000,000-gallon and two 4,000,000-gallon vertical triple expansion pumping engines, with boilers and appurtenances complete, for the high-service works at the new aqueduct: Henry R. Worthington, New York, $116,950; Snow Steam Pump Works, Buffalo, $123,000; Groshon High-Duty Pumping Engine Co., New York, $114,500; E. P. Allis Co., Milwaukee, $144,000; Geo. F. Blake Mfg. Co., New York, $110,000; Holly Mfg. Co., Lockport, N. Y., $143,300.

St. Louis, Mo.—The following bids were opened Nov. 14 for two 30,000,000-gallon low-service pumping engines for the Chain of Rocks pumping station: Southwark Foundry & Machine Co., Philadelphia, $201,700; Ranken Fritsch Foundry & Machine Co., St. Louis, $193,490; Holly Mfg. Co., Lockport, N. Y., $281,000; Henry R. Worthington, New York, $220,000; Edward P. Allis Co., Milwaukee, $156,000. Bids opened by the water department for two 10,000,000-gallon pumping engines were published in our issue for Sept. 28, under Water-Works.

Philadelphia, Pa.—Bids were opened Nov. 7 for four 20,000,000-gallon pumping engines for the new pumping station at Queen Lane reservoir, the bidders being: A, Groshon High-Duty Pumping Engine Co., New York; B, Henry R. Worthington, New York; C, Edward P. Allis Co., Milwaukee; D, Southwark Foundry & Machine Co., Philadelphia; E, Snow Steam Pump Works, Buffalo; F, I. P. Morris Co., Philadelphia; G, Holly Mfg. Co., Lockport, N. Y. The prices were as follows:

		Engine			
Bidder.	Type.	1st.	2d.	3d.	4th.
A	Triple expans'n.	$82,400	$82,000	$82,000	$82,000
A	" "	85,000	85,000	85.000	85,000
A	Compound	75,000	75,000	75,000	75,000
B	"	65,000	63,000	61,000	58,000
B	Horiz. triple.	70.000	68,000	66,000	64,000
B	Vertical triple.	91,000	89,000	87,000	85,000
C	" "	115,000	115,000	115,000	115.000
D	" "	75,787	75,287	74,287	73.787
E	" "	97,500	97,500	97,500	97 500
F	" "	120,490	115,990	115,990	115,990
G	" "	85,000	84,000	83,000	82,000
G	Compound	68,000	67,000	66 000	65,000

MISCELLANEOUS CONTRACTS AND SUPPLIES.

DYKE.—Indianapolis, Ind.—The board of public works will receive bids until Dec. for a dyke along Fall creek.

FIRE HOSE.—Warsaw, Wis.—Bids are asked until Dec. 4 for 1,000 ft. 2½-in. rubber-lined cotton hose. J. C. Kuhlmann, Cy. Clk.

GARBAGE DISPOSAL.—Syracuse, N. Y.—The board of health will receive bids until Dec. 1 for the erection and maintenance of a garbage disposal plant.

GAS.—Jefferson City, Mo.—The city council is trying to secure better and cheaper gas, the charter of the present gas company having expired. J. P. Pooth, Chn. Com.

STREET CLEANING.—Cleveland, O.—The board of control will receive bids until Dec. 13 for cleaning the paved streets and alleys of the city for the year 1894, the city to be divided into three street cleaning districts.

MARINE RAILWAY.—Victoria, B. C.—Press reports state that the Esquimalt Marine Co., composed of Victoria capitalists, with W. F. Bullene as managing director and a capital stock of $100,000, has begun the construction in Esquimalt harbor of a marine railway for docking and repairing vessels more cheaply than by the usual drydock methods. Vessels up to 300 ft. long and 19 ft. depth will be floated on a cradle, then pulled up an inclined railway 700 ft. long on six tracks by powerful machinery. Shops for repairing machinery and woodwork will be erected, the whole to cost $60,000. The plant will be in readiness for operation in February.

INDUSTRIAL NOTES.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa., have delivered some passenger engines to the Cairo Short Line, and have leased 25 freight engines to the Atlantic & Pacific for two years.

THE MISSOURI CAR & FOUNDRY CO., St. Louis, Mo., is building 200 coal cars for the Kansas City, Pittsburg & Gulf.

THE JACKSON & SHARP CO., Wilmington, Del., is building 15 passenger cars for the Jacksonville, St. Augustine & India River.

THE J. G. BRILL CO., Philadelphia, Pa., has an order for 50 electric cars for the City Passenger Ry., of Baltimore, Md. They will be 26 ft. long and equipped with two 30 HP. Westinghouse motors. Ten grip cars are also being built for the Baltimore cable lines.

THE GEO. F. BLAKE MFG. CO. furnished the entire outfit of steam pumps to the now famous "Columbia," including the main air pumps. The same company furnished the pumps for the cruiser "New York" and for the ferryboat "Netherlands," which has lately made such a fine record in her trial trip.

THE ENGINEERING IMPROVEMENT CO., Chicago, has been incorporated to carry on a general contracting and constructing business in civil and mechanical enginerring. It will own and control specialties for the improvement of steam and power plants, and has the Western agency for the Hussey reheater, which is in extensive use in the New England and Middle states. Pres. and Treas., E. T. Williams; Vice-Pres. and Gen. Man., V. A. Thomas; Sec. and Chf. Engr., T. H. Williams. The offices are in the Monadnock Block.

GIFFORD BROS., of Hudson, N. Y., inform us that the Suburban Electric Co. has contracted with them for the installation of counter-shafting, friction-clutch pulleys and quills, cut-off couplings, etc., for its plant at Elizabeth, N. J.

C. E. LOSS & CO., Pullman Bldg., Chicago, has about 300 men macadamizing and improving the roadbed of the Calumet electric railway from Grand Crossing to South Chicago, six miles. Mr. Loss has about 200 men at work on his contract for street improvements at Harvey, Ill., and improving 93d St., Chicago, from Cottage Grove to Stoney Island Ave. This work also includes changing the line of electric railway to run around the Nickel Plate R. R. shops at 93d St. and Stoney Island Ave.

STEEL WORKS.—It is reported that the $15,000 needed to effect a reorganization of the Belleville Steel Co., of Belleville, Ill., has been subscribed by the business men of Belleville and the members of the Amalgamated Association of Iron and Steel Workers. The new company will be incorporated, and the steel plant put in operation as soon as possible.

NEW COMPANIES.—Convertible Car Mfg. Co., Chicago, Ill.; $1,000,000; Frank H. McCulloch, E. Bornemann and A. R. Widowson. Ferguson Contracting Co., East St. Louis, Ill.; $15,000; E. E. Parks, C. E. Barnes and E. C. Chapin. Chicago Culvert Co., Chicago, Ill.; $100,000; P. B. Lane, John H. Curtis and C. P. Johnson. Keystone Coal & Construction Co., Emporia, Kan.; $1,000,000; John B. Glaze and William Roles. Wisconsin Pipe & Fuel Co., Eau Claire, Wis.; $10,000; Henry Laycock, J. F. W. Ritsch and B. J. Proctor. Sanitary Heating & Ventilating Co., Peoria, Ill.; $10,000; Robert Strehlow, C. F. Cooper and R. H. Lovett.